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EDITORIALS.

Teaching How to Study.—It is remarkable that, in spite of the primary purpose of the technical school, so little attention has been given to the fundamental principles of study. In this issue a paper by Professor Geo. L. Sullivan, to be presented at the Princeton meeting, is printed. Professor Sullivan outlines an experiment in study teaching which he has been conducting with success. Other papers along the same line will probably form part of the Princeton program. There is a prevalent notion among students that education can be obtained by a mechanical process. Assuming that students are conscientious, they have a right to assume that if they follow the suggestions of their teachers they will become educated. As the writer looks back over his college work he remembers a sense of pleasure at the novelty and progress indicated by transfer from one course to another, but he does not remember having had presented to him at the outset a clear statement of the purpose of each course and the way in which it should be pursued. Is not the following somewhat the routine of many courses? Teacher assigns three pages of translation; schedule allows two hours for preparation; dictionary states what words mean; grammar gives sentence formation; translation is made; learner reports at class-room and is checked in; teacher takes inventory of new stock of words and rules; records same; learner is checked out with new assignment; learner loses sense of responsibility for stock covered by preliminary inventory until near time for general inventory, after which all responsibility ceases. Friend says, "Well, how is German coming on? Learner responds "Passed it, 80 per cent." A student unconsciously gets the idea that by some such bookkeeping scheme, in a mysterious way, an education can be obtained; that education, in other words, is a sort of manufacturing process, study being one of its important kinematic combinations. Obviously, there is no single thing

that a teacher can do for a student that will benefit him more than to teach him how to study. The consideration of this subject at Princeton cannot but be of great benefit to teachers and students.

Progress on the Princeton Program.—As the date of the annual meeting approaches and the program loses its nebulous character it is quite evident that the meeting is to be a very profitable one. The committee in charge is planning to group the discussion under a small number of topics allowing ample time for the consideration of each. The new committee on sociability will have its duties also in "breaking the ice" for everyone at the start so that the most may be made of the opportunity to cement old friendships and form new ones. The location of the convention is ideal for social purposes and the historic surroundings of the university will tend to develop a contemplative spirit. It is suggested that members come as early on Tuesday as possible so as to make the most of the meeting.

Modern Practice in Lettering.—A charge is frequently made against technical students that they cannot do neat lettering. A somewhat parallel charge that their skill in arithmetic is poor. These two charges result from the tendency of technical students to slight trifles, as they seem to them. There is no valid reason for lack of skill in these two items of technical work as ample time is devoted to lettering and to arithmetic in the school course. Teachers have a right to insist on neat and accurate work. That such insistence, as far as lettering is concerned, will produce good results is indicated in the paper by Mr. H. O. Rugg printed in this issue. Mr. Rugg has conferred a favor on the Society by making the BULLETIN the medium of publication of the results of an elaborate research on present practice in lettering. While this is a detail of technical instruction it is an important one and merits the careful attention of the Society.

Socializing Education.—Mr. Rayner's paper on this subject brings to mind another criticism of technical graduates. It is claimed by some that young men fresh from school seem to have the idea that engineering is largely made up of the kind of material which they have covered in their technical courses. As we all know this is far from being the case as large engineering problems are social rather than technical. A technical foundation is, of course, absolutely necessary but students should not get the idea that they will be successful in life in the large sense if they are merely good designers or analysts. Students should take an active part in activities such as athletics, literary work, etc., and at the same time if they are really interested in their studies, those who do so are apt to make the best engineers because they know how to get along with people and to get results in coöperation with others. For this reason students should be encouraged to consider the relations of their college studies to their future duties as citizens.

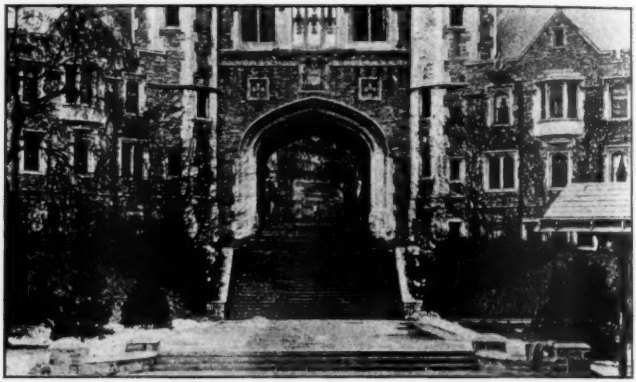
ENCOURAGEMENT FROM OUR FRIENDS.

The members of the Society will be encouraged to know how their work is regarded by competent critics. Among the many complimentary notices which reach the Secretary's office, none have given the officers greater satisfaction lately than a letter from Dr. Hollis Godfrey stating that the year-book is a very satisfactory production and a note regarding Part II of Vol. 20 of the *Proceedings*, in the February *American Mathematical Monthly*. The latter states: "This volume is a splendid example of what may be done to share with all the members of a society and with others outside the society the full benefits of the annual meetings. According to the well-arranged statistics which form the introduction, the membership of the Society numbered 1,166, while only 215 members and guests attended the Boston meeting; yet the report of the treasurer shows that with an annual fee of four dollars the budget makes possible the distribution to members of the full pro-

ceedings of the annual meetings as well as of a monthly BULLETIN. Why may not this be done in more of our American societies than is the case at present, whether these are directly educational or not? It is at times exceedingly difficult to obtain certain papers on a given program, inasmuch as the publishing of these is scattered over a wide range of journals. This BULLETIN, by the way, affords an active forum for a live and even spicy discussion of matters bearing particularly on the teaching of engineering subjects, and enables a group of members to carry on during the year an exchange of opinions and a comparison of methods which cannot at all take place with such fullness and deliberation in connection with the all too crowded programs. The practical question fairly forces itself upon our attention as to the possibility of such interchanges on the part of those interested in the teaching of mathematics. A suggestion lies close at hand. Can this be done through the columns of the *American Mathematical Monthly*?

"Another valuable feature is the animated discussions which follow the presentation of a set of papers clustering about a common topic, as witness the shorter comments and somewhat more extended criticisms in the BULLETIN called forth by a paper on 'The Teaching of Elementary Physics,' or the discussion following a valuable report which collates the results of an investigation of the mechanical engineering laboratories in more than twenty-five institutions in this country with regard to equipment, personnel and methods. The remarks made are always 'parliamentary' and in good spirit, but are given now and again 'without gloves'; and woe be to the man who has a hobby, or who expresses his opinions either immoderately or vaguely!

"Aside from the articles just referred to, there may be singled out for mention papers on 'The Faculty Seminar,' on 'The Hydraulic Equipment at The Ohio State University,' and on 'The Engineering Laboratories of the Royal Technical University at Charlottenburg, Germany.''



Princeton Campus—Entrance through Tower of Blair Hall, from Railroad Station.

GREETING FROM PRESIDENT HIBBEN.

PRESIDENT'S ROOM, PRINCETON UNIVERSITY,

Princeton, N. J., April 18th, 1914.

We are anticipating with much pleasure the coming convention at Princeton of the Society for the Promotion of Engineering Education, and I wish to extend, in the name of the university, a very hearty welcome to all its members. I am sure that this meeting will more than ever establish us in our conviction that the study and practice of engineering is indeed one of the learned professions.

JOHN GRIER HIBBEN,
President.

SOCIETY BUSINESS.

THE COMMITTEE ON STATISTICS is conducting an elaborate investigation of the following subjects:

1. Summer work as a part of the educational course;
2. Results of summer employment on students;
3. First year pay for technical graduates;
4. Attendance immediately before and after vacations;
5. Statistics as to numbers of students enrolled in different years.

TREASURER'S APPROXIMATE QUARTERLY STATEMENT.

NEW YORK, April 20, 1914.

In accordance with the request of the executive committee I submit an approximate statement of the cash in hand and accounts receivable on this date. If back and current dues are paid promptly there should be no difficulty in paying all obligations before I close my books for the year on June 15.

Bank balance		$1,661.32
Back dues outstanding	$ 295.00	
Current dues outstanding	1,086.50	
Due on publication and advertising	354.73	
Due from institutional members	50.00	1,786.23
Total		$3,447.55

Respectfully submitted,

W. O. WILEY,
Treasurer.

PRINCETON LOCAL CONVENTION COMMITTEE.

President John G. Hibben, of Princeton University, has appointed the following local committee: Dean Fine, *chairman,* Professors McMillan, Harris, H. S. S. Smith and F. N. Wison.

Mr. Chas. S. Higgins is also coöperating with the program committee in the preparation of the program and has secured the promise of Governor Jas. F. Fielder to address the convention.

APPLICANTS FOR MEMBERSHIP.

INDIVIDUALS.

CULLIMORE, A. R., Professor of Civil Engineering and Dean of the College of Industrial Science; The Toledo University, Toledo, O. 1914

FISK, W. C., President, Hudson & Manhattan Railroad, 51 West 73d St., New York City 1914

HARRIS, W. B., Professor of Geodesy, Princeton University, Princeton, N. J. 1914

MILLER, A. V., Assistant Professor of Drawing, University of Wisconsin, Madison, Wis. 1914

INSTITUTIONS.

MUNICIPAL UNIVERSITY OF AKRON, College of Engineering, Akron, O., F. E. Ayer, Dean 1914

VANDERBILT UNIVERSITY, NASHVILLE, TENN., J. H. Kirkland, Chancellor 1914

PUBLICATIONS RECEIVED.

The Engineering Magazine for April, 1914, prints the first of a series of articles by Horace L. Arnold under the heading "Ford Methods and the Ford Shops." The series should be of especial interest at this time, following the "Ford Bonus Announcement." This introductory paper lays a foundation for the specific descriptive articles which will follow.

The Mortar-Making Qualities of Illinois Sands, by C. C. Wiley. Bulletin No. 70. Engineering Experiment Station of the University of Illinois. Price 25 cents. Due to the great difference in the quality of mortar made with different sands, the results given in this bulletin should be of value to contractors. The author finds that sharp sand, contrary to the general idea, does not make as strong mortar as rounded sand. In conclusion there is given a set of proposed specifications for various grades of sand.

Government Ownership of Electrical Means of Communication. 63d Congress, 2d Session, Document No. 399. This report, prepared by a committee of the post office department, is in favor of government ownership and control of the telephone and telegraph lines. The Document of 148 pages gives, in the form of appendices to the report, a historical résumé of the agitation for government ownership of the telephone and telegraph lines of the U. S., and voluminous data bearing on the subject compiled from many publications, native and foreign.

Syllabus, 1914. The Department of Public Instruction, Queensland. Giving the outlines of the courses of instruction in the technical colleges of Queensland.

The Iowa Engineer, Vol. XIV, No. 6. March, 1914. Among several interesting engineering articles this number contains a short paper by K. G. Smith, professor of engineering extension, entitled "Some Results of Engineering Extension." These notes bear the more weight because collected from personal experience. The employers, while "harder to educate than the employees," are gradually appreciating the advantages to them of the extension work among their workmen, and are giving more and more time to it. Interesting cases of benefits derived from the course are cited.

Proceedings of the Second Meeting of the Land Grant College Engineering Association, held in Washington, D. C., November 11–14, 1913. The pamphlet of 110 pages was edited by Dean G. W. Bissell, secretary, and gives in detail the minutes of the meeting and the papers presented to the Association.

The Beacon, Vol. VII, No. 24. Special college number. This issue of the weekly published by the students of the Rhode Island State College is profusely illustrated with college views. An excellent reproduction of a panorama of the campus from the roof of Science Hall occupies the place of honor across the center double-page.

Science, for March 20, 1914, prints an address given on the ocasion of the inauguration of the first president of the University of Manitoba, on November 19, 1913. The address, entitled "The Provincial University in Canadian Development," discusses in detail the special problems confronting Canada in her educational development.

The Washington Alumnus, Vol. VIII, No. 3. This number of the official organ of the University of Washington Alumni Association devotes considerable space to the new president. In an article entitled "Henry Landis as President" and in an editorial reviewing the achievements of the President at the end of his first month in office, one notes the enthusiastic support and confidence given him and his policies.

Mr. E. B. Norris calls attention to an article "Educating the Man in the Shop," in *Engineering Record,* March 7, 1914, page 280.

PERSONAL.

Mr. Jay Turley, of El Paso, Texas, is consulting engineer for the state of New Mexico in the boundary line dispute now being argued before the United States Supreme Court. The area involved is about 30,000 acres under the Eagle Dam project representing about $6,000,000 in taxible value.

COLLEGE NEWS.

Brown University.—Progress is being made on the program of the one hundred and fiftieth anniversary to be held October 11–15, 1914. A feature will be a play "The Provoked Husband, or a Journey to London," which was produced in Newport in 1761 by a company of comedians from Virginia who performed also in Providence in 1762, two years before the founding of the University. There will be seven meetings for formal addresses, a daily organ recital and concert by the Mendelssohn Club of New York, illumination of the campus, historical pageants, etc. A number of lectures on scientific and general subjects will be given, including two by President A. C. Humphreys on "Broader Training for the Engineer."—Professor W. H. Kenerson gave an illustrated talk on "Fire Protection and Automatic Sprinkler Systems," at a recent meeting of the Detroit Engineering Society. He discussed the function of a sprinkler system and described it, dealing with the relation of water supply to automatic fire protection; the results of automatic sprinkler protection, and its value as a life-saver; the efficiency of automatic sprinklers and risks of various occupancy.

Case School of Applied Science.—A summer course in highway engineering will be given between July 1 and August 14 under the direction of Mr. M. B. Greenough. This will be opened to all students of technical schools who have credit in pure and applied mechanics and plane surveying. The course will consist of seven parts as follows: Economics and Preliminary Design; Construction and Maintenance of Improved Roads; Bituminous Pavements and Road Oils; Highway Bridges and Culverts; Testing of Non-Bituminous Road Materials; Field Work and Highway Location and Inspection Trips, Topics and Reports.

State University of Kentucky.—The college of mechanical and electrical engineering, of which Professor F. Paul Ander-

son is dean, has a new development of the thesis policy for this year. A power plant of 15,000 kilowatt capacity, large enough to furnish light and power to all of eastern and central Kentucky, is being designed by the best men in the other classes. In this undertaking they have the coöperation of the firm of Sargent & Lundy, Chicago.

Massachusetts Institute of Technology.—The department of civil and sanitary engineering will offer a course in highway engineering under the charge of Professor C. M. Spofford in addition to those previously offered in railroad engineering and hydraulic and sanitary engineering.

University of Washington.—Dean Fuller reports that the courses have undergone a thorough revision in the course of which provision has been made for electives with the idea of encouraging students to pursue studies in political science, etc. This revision resulted in the appointment of a committee of four men each from the departments of mathematics and engineering to correlate the various subjects in mathematics among themselves and with the engineering work. This movement is very promising.—The faculty and seniors recently gave "a college night" to all of the alumni who could be reached. Nearly 1,000 attended.—On March 24, students and faculty of the colleges of engineering and mines inspected the headworks of the city lighting plant at Cedar Lake. On arrival at Cedar Falls the party was divided into squads of about twenty men each, half of them going directly to the lake, while the rest were taken through the power plant under the direction of the station officials and Professor C. E. Magnusson. The present plant is located in a temporary building and with the completion of the new dam next summer the installation for utilizing the 50,000 horse power then available will be located in a permanent concrete structure directly across the river. Fourteen thousand horse power represents the total energy available under the present conditions and in the summer months Cedar Lake is nearly drained dry.

THE ENGINEERING EXPERIMENT STATION OF THE PENNSYLVANIA STATE COLLEGE.

BY E. D. WALKER,

Acting Dean of the Engineering College.

During the last year the work of the Engineering Experiment Station has been confined to five particular investigations as follows:

1. The investigation of heat transmission through building materials and also the effect of air velocity and humidity on the rate of transmission. A preliminary report on this investigation has been presented in a paper read at the Third Congress of the Association Internationale de Froid and was very favorably received. Abstracts of this paper have been published in many of the leading technical papers. A bulletin has not yet been prepared on this subject.

2. Research work has been continued along the lines of investigating the commercial applicability of the various substitutes for gasoline in engines. Bulletin No. 7 gives a discussion of the tests which have been made to date, with such substitutes as kerosene, alcohol, and motor spirits. Mixtures of kerosene with gasoline as well as the mixture of alcohol with water have been tried and are reported here. Special attention was given to the effect on power and economy of automobile and stationary engines by the use of apparatus for "injecting" water and air into the explosive mixture after leaving the carbureter. Results of these last investigations should be especially useful to engineers as the data available on these subjects are very limited.

3. A most important investigation which has been in progress for the last two years is the determination of the distribution of vertical pressures in earth, particularly as regards culvert construction. These researches were conducted in the laboratories of the school of engineering in coöperation with

the state highway department. Data and results are given in Bulletin No. 8 which includes by far the most complete data ever published on this important subject.

4. In coöperation with the engineers of the signal department of the Pennsylvania Railroad, important results have been obtained regarding the absorption of ultra-violet light by various kinds of glass.

5. The heat treatment of steel in electric furnaces with accurate temperature determinations and the measurement of the important physical changes and properties has been continued successfully. Bulletins on the last two subjects are now in preparation.

A revision of the bulletin on "Notes on the Design of Blower Heating Systems for Factory and Shop Buildings" is also being published at this time as No. 9. There has been a great demand for this bulletin, and in order to make it more serviceable to the man without a technical training many references and footnotes have been added.

THE TEACHING OF ELEMENTARY MECHANICS.

BY WM. KENT,

Consulting Engineer, New York City.

I wish to take a hand in the discussion between Dr. Dadourian and Professor Huntington on the subject of "the difficulties which the student of elementary mechanics encounters."

I agree with both of these writers in condemning the use of the terms "poundal," "gee-pound" and "slug." It is greatly to be hoped that they will be abandoned in all future textbooks.

I agree with Professor Huntington in condemning Dr. Dadourian's attempt to introduce the term *libra* to denote "the pound-weight" as "absolutely futile" and "a violation of language." By the way what is the "pound-weight?" The term is sometimes used to mean the piece of metal known as

the standard pound, or reproductions of it, and sometimes to mean a pound force. That the use of the term *Libra* (lb.) only introduces confusion is exemplified by the fact that I am utterly confused by Dr. Dadourian's expression "The simple and perfectly definite relation 1 lb. = g. pd." If 1 lb. (libra) means one pound force, and pd. means quantity of matter in pounds, and $g. = 32.2$, then it appears that the equation when put into figures is $1 = 32.2$.

I agree with Professor Huntington in his statement that "there is certainly no confusion, but rather a great and well-recognized convenience, in the fact that the force exerted by gravity on a pound-mass in the standard locality, is precisely one pound of force" but I would substitute for the term pound-mass the expression pound of matter, which has no possible ambiguity.

I do not agree with Dr. Dadourian in holding that confusion arises from using the same term "pound" to denote the units of both magnitudes (mass and force). The context always shows which magnitude is meant. "A boiler evaporates 1,000 pounds of water per hour into steam of 100 pounds pressure." The words "per square inch" may be added if precision of statement is needed, but nobody who knows anything of a steam boiler, even if he is a freshman student, is in any confusion as to the two meanings of the word "pounds" in the sentence quoted. In the first instance it means pounds of matter as weighed on a platform scale, and in the second it means pounds of force as measured by a steam gage.

I do not agree with Professor Huntington in calling the equation $F/F_1 = a/a_1$ the fundamental equation. It is a good equation for certain purposes, and may be used as a basis of other equations, but it cannot be fundamental because a and a_1 are derived and not simple quantities. That the masses (quantities of matter) do not appear in the equation is rather a disadvantage than an advantage. If we are dealing with both matter and force then a fundamental equation should include both. I would derive the fundamental equation from the following statement of an experimental fact.

A constant force of 1 lb. acting on 1 lb. of matter (at rest but free to move in the direction of the force) during one second gives it a velocity of 32.2 (or g) ft. per second (more precisely 32.1740 ft. per second). If the force acts for 2, 3, 4 seconds the velocity at the end of the time is $2g$, $3g$, $4g$, etc., or if the time is 1 second and the force 2, 3, 4 lbs. (W constant at 1 lb.) the velocity is $2g$, $3g$, $4g$; that is, the acquired velocity varies directly as the force and as the time. Also if 1 lb. force acts for 1 second on 2, 3, 4 lbs. of matter, the acquired velocity at the end of 1 second is $\frac{1}{2}g$, $\frac{1}{3}g$, $\frac{1}{4}g$. Force acting during time causes matter to acquire velocity. The effect is proportional to the cause, hence the equation

$$F \times T = WV \div g \qquad (1)$$

in which F = force in pounds, T = time in seconds, V = velocity in ft. per second at the end of the time T, W = weight in pounds. Weight is either the quantity of matter as weighed on an even balance or the attraction of gravitation on that matter at Lat. 45 deg. at the sea level, these two things being numerically precisely the same.

If F, T and W each $= 1$, $V = 32.2$, and $1 \times 1 = 1/32.2 \times 1 \times 32.2$. If we let $M = W/g$ then equation (1) becomes

$$FT = MV. \qquad (2)$$

If $V/T = a$ we obtain

$$F = Ma \qquad (3)$$

also substituting a for V/T in (1)

$$F = Wa/g,$$

whence

$$F/W = a/g, \qquad (4)$$

which is one form of Professor Huntington's so-called fundamental equation.

The trouble in teaching mechanics is chiefly due to the textbook writers, as stated in my paper in *Proceedings of the Society for the Promotion of Engineering Education* (Vol. XIX, 1912, p. 301). I am disappointed that no one has accepted

the challenge in that paper, namely, to write out a definite statement of just how an elementary text-book should treat the subject, and see if the treatment I gave can be improved upon. Professors of mechanics are too busy to give time to the matter, no doubt, so I am going to propose something easier, that is that they get their students to do it for them. I suggest that they take a class of junior students in engineering, who are supposed to be able to write good English and also to be able to use their elementary mechanics as a working tool, and ask them to answer in writing the following questions:

(*a*) A constant force F lbs. acts during T seconds on W lbs. of matter free to move in the direction of the force. At the end of the time what are

(1) The total space traversed?
(2) The acquired velocity?
(3) The momentum?
(4) The kinetic energy?
(5) The acceleration?

(*b*) Give numerical values to F, T and W and solve a simple problem arithmetically, without using algebra.

(*c*) Give algebraic formulæ showing the relation of (1), (2), (3), (4), (5) to F, T, and W.

(*d*) Explain the derivation of the formulæ, defining all the technical terms used, in language that may easily be understood by a high school student who has studied algebra as far as the solution of simple equations, but who has not studied mechanics.

When the papers are all handed in let them be turned over to the members of another class, say a senior class, for criticism. Have them examined and reported on as to accuracy, completeness, precision, clearness, simplicity and brevity.

If any professor will obtain from his students a lot of papers containing answers to the above questions and the criticisms of such papers by other students, and will send me say half a dozen of the best ones, I will undertake to examine them and write a critical review of the methods used in solving the problem, for publication in some future issue of the BULLETIN.

FOUR VS. FIVE YEARS FOR THE ENGINEERING COURSE.[1]

BY WM. G. RAYMOND,

Dean of the College of Applied Science, the State University of Iowa.

I am not disposed to quarrel at all with Professor Swain's position in this matter of four or five years in engineering education. I should like to say a few things, however, concening some points brought out by President Humphreys.

On page 630 (May, 1913, BULLETIN) Mr. Humphreys asks if the colleges of engineering at any time in their history have given their students a complete training for life's work and responsibility. Of course the answer is "No" and the question has no bearing on the subject under discussion because no one proposes to give students a complete training.

On page 631 Mr. Humphreys asks in the second paragraph if the present conditions are so different from those of the past that in four years a student cannot acquire a sufficient grasp of science and mathematics as will enable him to reach the highest attainable rank for which his personality qualifies him. I think no argument is needed to back the assertion that the conditions are very different, and I think anyone who is familiar with college methods thirty years ago and the stock of engineering knowledge thirty years ago, even fundamental knowledge, would recognize the fact that it will take longer to acquire simply the fundamentals now than it did then, and I am afraid that the distinguished President of Stevens Institute is not making sufficient allowance for those intellects less capable than his own who do need more than the fundamentals which he received to enable them to attain the highest rank for which their personalities qualify them.

In the fourth paragraph on page 631 President Humphreys asks: "Are not we of the engineering colleges too apt to be led

[1] Discussion of papers by Prof. G. F. Swain, S. P. E. E. BULLETIN, *Proceedings*, Vol. 21, p. 320, and President A. C. Humphreys, BULLETIN, *Proceedings*, Vol. 21, p. 321.

astray by thinking that we must turn out a finished product?" It is possible that some engineering teachers do think this, but I believe they are largely in the minority. I think no really sane engineering instructor believes that either all culture or all technical knowledge is to be obtained in the school and I think that almost all of us are agreed that we can give only the fundamentals.

We do not need to be frank as is suggested in the next paragraph to acknowledge this fact, and it seems to me in this paragraph that President Humphreys has put up a bugaboo for the sake of knocking it down. On the next page President Humphreys seems to be arguing that because no man could secure all knowledge even if he were to stay in school for a life time, he should be limited to four years. But one may well ask why four years, why not three years, why not two years, why not one year, why any years at all, why not let him get all of his culture or information in the school of experience? It seems to me that this part of the argument is very much beside the point. I think we all recognize that some time is needed,—it may not be four years or three years or five years or seven years, and it may be four years for one man and seven years for another. What is needed is enough time to give fundamental principles and so far as they can be acquired sound reasoning habits, not ability—we cannot give that—but somewhat of that knowledge of human experience called history, somewhat of economics, and such other sociological subjects as will enable the graduate to meet his fellow men of education on a level.

President Humphreys raises the question: "What grade of capacity and ability shall we take as standard?" And it seems to me that we are obliged to say that we will take nothing as standard. Some men learn slowly and some men learn rapidly, and it cannot be said from this fact alone that the one is abler than the other. It may be a case of tortoise and hare and it is my judgment that we should adapt our courses to all men who seem to possess reasonable ability, allowing the slower

ones more time and allowing the quicker ones to complete their work in less time. As some of my readers will doubtless remember, this is a plan that I have been advocating for some years. It is a plan toward which we are working in the school with which I am connected, and I am very much pleased to note that the more advanced public school men of the country are rapidly coming to the conclusion that our present public school methods which are supposed to adapt work to the average pupil are all wrong.

President Humphreys says that if we adapt our work to the average man, the exceptionally brilliant men need not feel that they are losing time by having to mark time to enable the average man to keep in line, but I say they are losing time and, while there is plenty for them to do and while perhaps some exceptionally brilliant men would find the proper things to do, there are other very brilliant men who are capable of making good in the world's work who would not employ their time to advantage and who fail to get into the world's work as early as they are entitled to get there because they are held back in school to keep step with men of less ability.

I think we can all say "Amen" to the paragraph that begins at the bottom of page 634, but it seems to me that the coördination suggested by the paragraph is one that must be the result of a proper administration rather than of individual effort on the part of the separate departments.

It is perhaps unnecessary to speak of the paragraph on the public schools below the college. I think we all recognize certain weaknesses of those schools and all of us who have anything to do with them (and I am one of those unfortunates who as members of the local school board have to do with them) are somewhat anxiously studying how to overcome the difficulties with the money that we can hope to raise by taxation.

I think there can be no doubt that if our entire school system were rearranged we could be graduating men at twenty years of age with just as much school training in cultural subjects and technical subjects as the average graduate of twenty-

two or twenty-three now has. I feel quite sure that we lose from two to three years of valuable time which we ought to recover in one or two ways either by getting the young men to work at an earlier age or by sending them to work at the same age as now much more thoroughly prepared.

Then let me answer President Humphreys' two principal questions thus:

I think that more time is needed in college for mastering the fundamentals than was needed thirty years ago because the fundamentals are more than they were thirty years ago, and the average student who does not master them in college is not likely to master them out of college.

Second, I believe the time in college can be much more effectively used than is now common. My experience with improved methods leads me to believe that what I think should be given in college to the men as we now get them from the high schools, and these are the men with which we must deal for the present, must be given in four years to exceptionally good men, in five to average men and in a longer time to the very faithful and substantial but slow men.

And what I think should be given in college comprises the fundamental principles of all branches of engineering, a little special training in one branch, a thorough drill in the use of the mother tongue, enough of a foreign language so that the graduate can use it with reasonable facility, actual American and foreign government, honest business methods and the holy principles of friendship, morality, and brotherly love; all these to the end that the graduate may plan wisely, build well and be able to distinguish between legitimate business profit and gross imposition. We need men who, whether they are connected with private business enterprises or with public service corporations which are public agents or directly with the departments of administration of public affairs, will realize that they are simply units in the great social system and owe it to society to use their best endeavors for the advancement of human welfare.

THE PRINCETON ENGINEERING ASSOCIATION.

BY CHAS. H. HIGGINS,

Secretary of the Association, Jersey City, N. J.

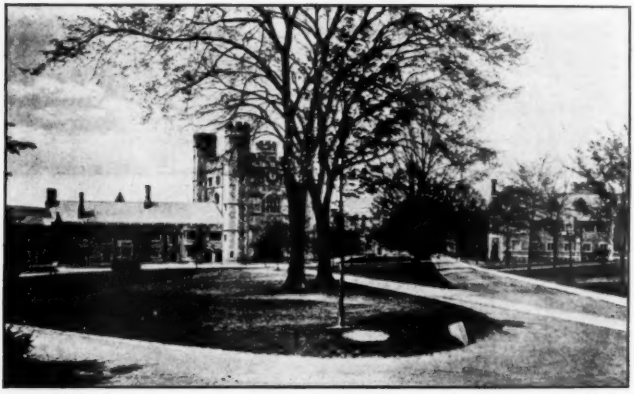
Princeton University first gave the degree of Civil Engineer in 1878. The influence of the Rensselaer Polytechnic Institute was strong in the inception and forming of the course. Two of her graduates, Prof. Charles McMillan and Prof. Fred'k N. Wilson, were chosen to take leading parts and they remain members of the faculty to this day. Until

Princeton Campus—Historic Nassau Hall, Headquarters for 1914 Meeting.

1899, this remained the sole engineering course at Princeton. In that year, the school of electrical engineering was established with a graduate course of two years leading to the degree of Electrical Engineer.

In the autumn of 1874, there were four students studying engineering at Princeton. By 1900, this number had grown to 130. At the present time, there are 174 students pursuing the engineering courses, of whom thirteen are graduate students working for the degree of Electrical Engineer.

Two years ago, the number of living graduates who had received a degree in engineering from Princeton, numbered about five hundred, while among the alumni there were more than this number who had been enrolled in the engineering course without finally receiving a degree. In addition to these men, there were a large number of alumni who had studied engineering at other institutions, after pursuing an A.B. or B. S. course at Princeton, and others, who through their work had become interested in and connected with various engineering undertakings.



Princeton Campus—Blair and Campbell Halls from the Campus Side.

During the winter of 1912, a number of engineers, alumni of Princeton, dined together at the Princeton Club of New York. One of the number had been a guest, for the past two years, at the annual dinner of the Harvard Engineering Society of New York. He told how enjoyable and inspiring these dinners were, bringing together, as they did, engineers from different classes and from various lines of endeavor. They met not only each other but also members of the faculty, both teachers of engineering and the administrative officers of the

university. It seemed to all present, that such an association of Princeton men, interested in engineering, would make for better acquaintanceship and good fellowship and might be peculiarly helpful to the younger men as they graduate and go out from the university. It also appeared to give opportunity for interchange of ideas between graduates and faculty, which could not but be helpful.

Those present formed themselves into an organizing committee and sent out an invitation to the alumni of Princeton, interested in engineering, saying in part: "We propose that the radiating action of this pebble, cast into the pool, shall eventually reach every Princeton man interested in engineering and that this association shall become the means of bringing about better acquaintanceship among its members and increase their helpfulness, both to each other and to the university, which has a place in all our hearts."

This invitation met with gratifying results, and in the spring, at a dinner, the Princeton Engineering Association was formed, w,ith these avowed objects:

"The objects of this Association shall be: to bring together men of Princeton interested in engineering; to make for better acquaintance, fellowship and mutual helpfulness among them, particularly among the men already established and the younger men as they come out from the University; to promote interchange of ideas between graduates and faculty and to strengthen the tie between its members and the university, to the end that the interests, influence and efficiency of Princeton University be advanced through its department of engineering."

The growth of the association, both in numbers and interest, has been steady and rapid. Less than a year after its organization, the association nominated one of its members for alumni trustee of the University and sent a letter to the alumni of Princeton which read in part as follows:

"By the nomination of Howard C. Phillips, C. E., '90, an idea, not new but only recently spread broadcast among the

busy graduates of old Nassau, has germinated, taken root and sprung up vigorously into a strong and spreading conviction; a conviction that, for the work ahead of us, a practicing engineer is needed on the board of trustees of Princeton."

Alumni engaged in all manner of business responded, showing a recognition of the engineering profession, which was very significant in a university of Princeton's traditions. It showed an awakened appreciation of the engineer, and Mr. Phillips was elected.

Another side of the association's activity is perhaps, best illustrated by an extract from the Secretary's report of last year:

"The Committee on Opportunities has, in at least twenty cases, successfully brought together the opportunity and the man. To illustrate: a member in Santo Domingo needed an assistant engineer; a member in Florida had completed an engagement and wanted a position. Each communicated with the association and within the month the member from Florida was on his way to Santo Domingo. But splendid as the work of this committee has been, it is only the formal nucleus; the spirit permeates the membership and many cases of helpfulness occur, of which there is no record on paper."

It has been found that other universities either have similar associations or are considering forming them, and already there has been intercourse with these associations of the most cordial kind, thus increasing the acquaintanceship of college men practicing engineering. For this acquaintanceship and the intercourse of the various associations, much good may result to the engineering profession at large and in that way to the public we serve.

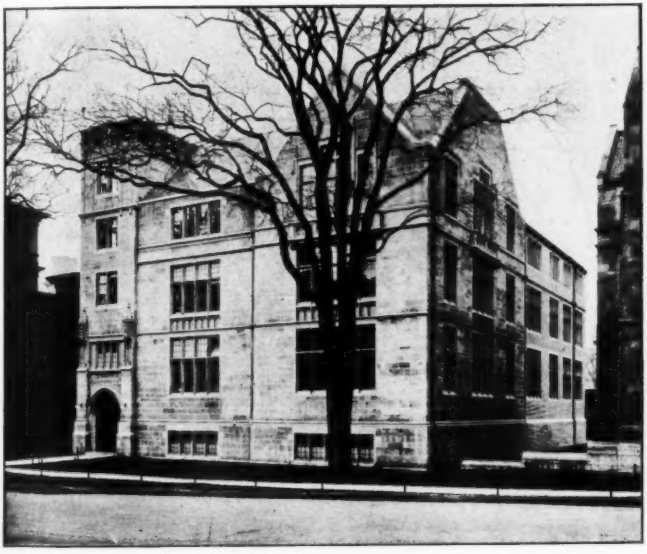
The Princeton Engineering Association is most gratified that the university is to have the honor and pleasure of welcoming the members of the Society for the Promotion of Engineering Education at Princeton this June. We feel that both associations are looking toward the same end and may be helpful to one another.

THE NEW ELECTRICAL ENGINEERING LABORATORY OF THE SHEFFIELD SCIENTIFIC SCHOOL OF YALE UNIVERSITY.

BY CLARENCE E. CLEWELL,

Instructor in Electrical Engineering, Sheffield Scientific School.

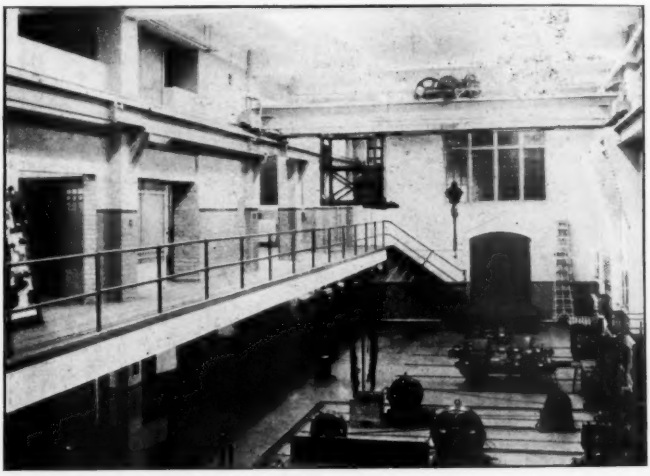
In the development of Yale University during the past eight years, the total number of graduates shows an increase of 40 per cent, while the classification by occupations indicates an



New Laboratory from the Front on Hillhouse Ave.

increase of over 100 per cent in the number engaged in engineering work. One result of this marked tendency towards engineering has been the establishment in the Scheffield Scien-

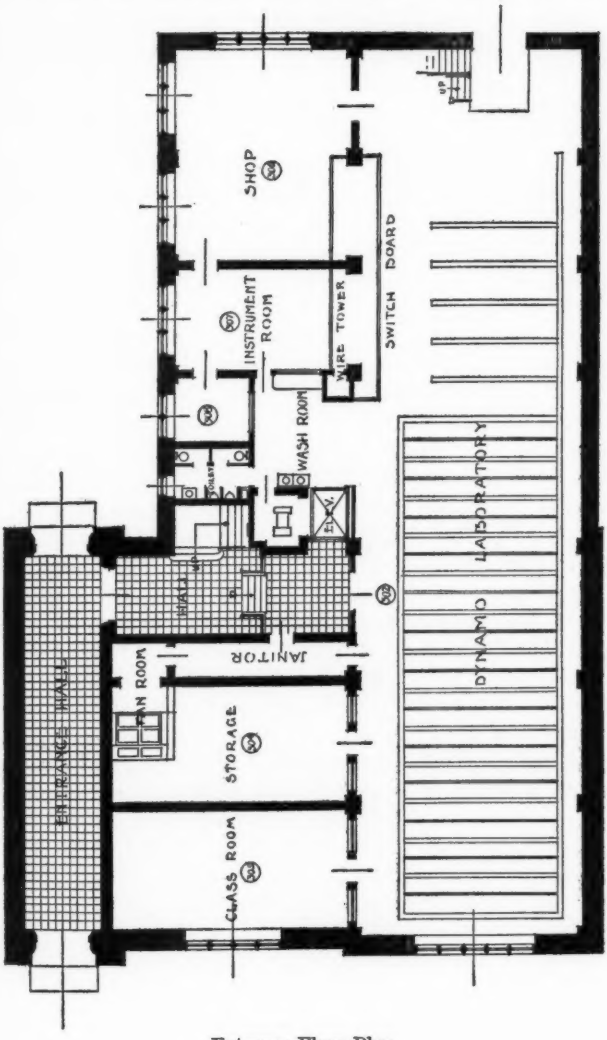
tific School of a chair in electrical engineering, and the addition of an electrical engineering department to the departments of mechanical, civil and mining engineering. The first step in the formation of this new department was the call extended about three years ago to Mr. Chas. F. Scott, consulting engineer of the Westinghouse Electric & Manufacturing Company, and past president of the American Institute of Electrical Engineers, to take up the development of electrical engineering in the Sheffield Scientific School, and in 1911 Mr. Scott assumed the duties of this new professorship.



Interior View of the Main Laboratory Showing Switchboard, Crane, Gallery and Apparatus.

A second step, the construction of a new electrical engineering laboratory, was made possible through the generosity of Mr. Austin C. Dunham, president of the Hartford (Conn.) Electric Light Company, and a graduate of Yale College in the class of 1854.

The new laboratory is located on the west side of Hillhouse

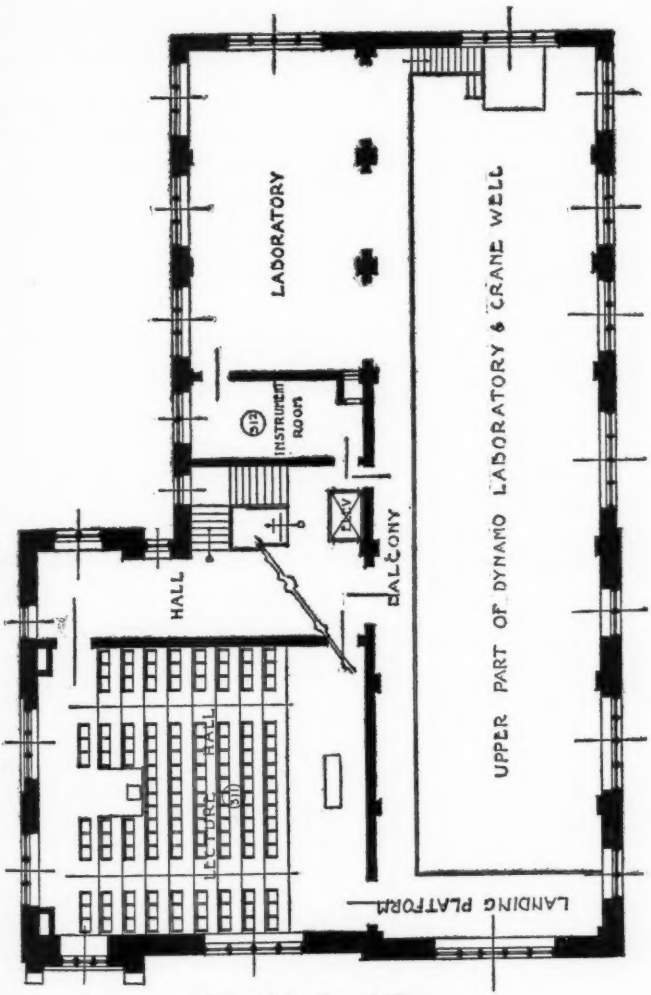


Entrance Floor Plan.

Avenue between Grove and Trumbull Streets in New Haven, and is opposite the Mason Laboratory of Mechanical Engineering, on a relatively small plot of ground between the Leet Oliver Memorial Hall to the north and the old biological laboratory to the south. The building is a four-story fireproof structure with a total floor area of about 25,000 square feet and presents, in a modest way, the ideals of modern construction. A general view of its appearance may be gained from the photograph taken from Hillhouse Avenue.

The contract was let in October, 1912, and the building was completed in September, 1913, less than one year later, classes and laboratory work having been started on the first day of the present college year. The architect, Mr. Henry G. Morse, of New York, embodied in the building a pleasing design as is shown in the photographic view. The front is finished in limestone with "economy" concrete trimming, and the various floor levels and construction lines are planned to harmonize with the Leet Oliver Memorial immediately to the north. The various floor plans illustrated herewith indicate the distribution of floor space for the different instruction purposes, and the photograph of the main laboratory room gives a general idea of the arrangements of switchboard, gallery and apparatus. The large window area provided throughout the building affords an abundance of natural light, and a carefully designed illumination system insures adequate artificial light when required.

The main laboratory room, located on the ground floor, consists of a floor area 115 by 30 feet, with a ceiling height of 27 feet. A five-ton Niles crane operates throughout the entire length of this room. A gallery at the front on the level of the lecture room floor provides a means for transferring apparatus from the main laboratory to the lecture room for demonstration purposes. At the west end a large door and platform give access to the building from the exterior driveway, for the unloading of machinery, which is placed on the platform and then transferred by the crane. The west end of the building as a whole takes the form of an extension ending to within a



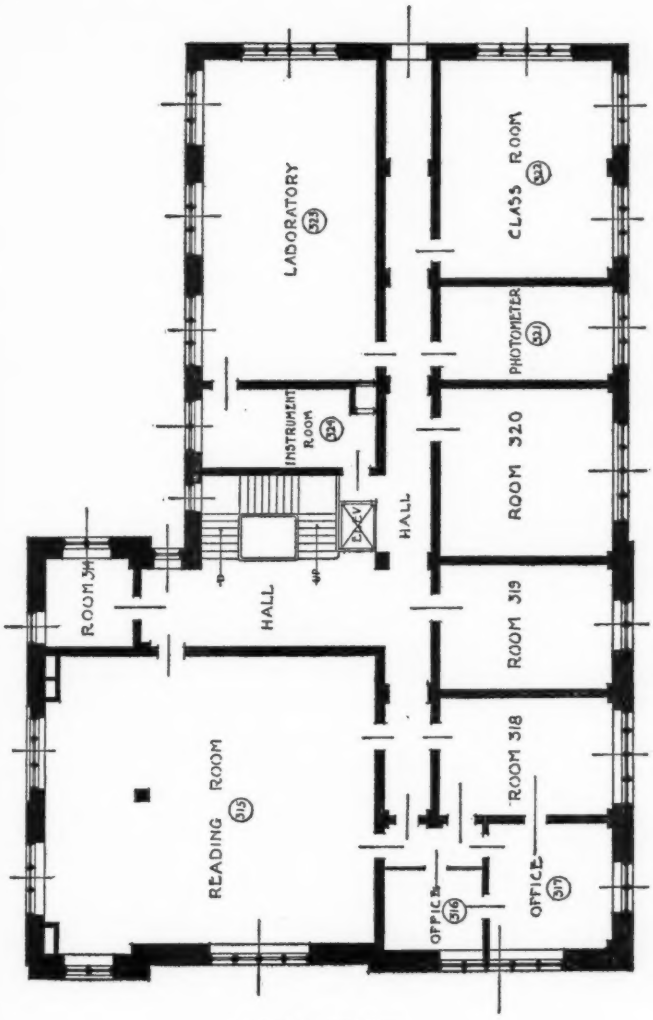
Plan of the Second Floor.

few feet of Winchester Hall. The wall construction of the extension is of light pressed brick with artificial stone trimming.

The main switchboard is located in the first floor laboratory towards the rear. A large pit under the switchboard, 7 by 7 by 30 feet, makes it convenient to carry wires from the switchboard through sleeves in the floor. From this board, power received from the plant in an adjacent building, is distributed over the entire laboratory. Access to the various floors for the wires from the main board is provided by a wire tower, which extends from the pit to the top floor at the "electrical center of gravity" of the building. This tower is connected to plug boards on the different floors for power distribution, and to panel boxes for lighting circuits. From these smaller distribution centers, conduits diverge through the concrete floors to each room. Openings are provided through walls and ceilings at various points, thus making it possible to run circuits for any purpose from the main switchboard to any points in the building in a convenient manner.

The lecture room on the second floor has a capacity of 200, the seating being arranged in straight line tiers. A large panel box at the front of the room contains the control switches for lighting and power, the lighting circuits being interconnected to a second panel box at the sterepticon lantern position in the rear of the room. This latter box also contains the control switches for the operation of the lantern. The lantern operator thus has full control of the lighting circuits, and at the completion of an illustrated lecture, the first position of the lighting switches throws the lamps in series groups, producing a low intensity of light, and avoiding the blinding effect experienced when the light is suddenly thrown on to full brilliancy.

The various diagrams show the general distribution of floor space for offices, lecture, computation, research, experimental, recitation and drawing use. A gallery adjacent to the first floor laboratory affords ample space for lighter apparatus and is furnished with a plug board and wall outlet boxes. The

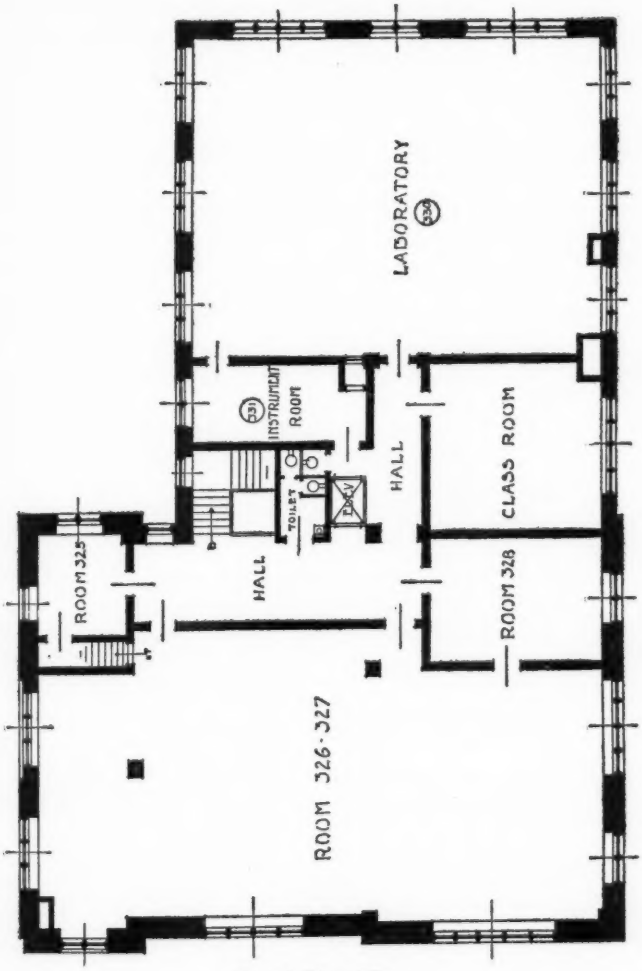


Third Floor Plan.

arrangement of the outlet boxes consists of a plain 7½ by 12 inch board, which covers the conduit outlet receptacle. On this board may be attached a knife switch (or switches) affording power supply along the walls of the rooms. A laboratory room on the third floor is used for the more physical experiments, and a large room on the fourth floor is fitted up with apparatus as an "Ohm's law laboratory." The latter room contains two short transmission lines, simple *visible* circuits for resistance measurements, various forms of electric lamps, and a variety of other apparatus for the more elementary laboratory work.

Rooms for storing electrical apparatus are located on each floor. These are directly over one another and are connected by a common shaft, thus providing a convenient scheme for the interchange of instruments between the various floors as required. An elevator, running from the first to the top floor, has an automatic stop device making it impossible to start in case any one of the various elevator doors happens to be open. The elevator stops automatically in case any door is opened while it is in motion, and also at the top and at the base of the building. The control cable passes up through the elevator shaft and down just outside the shaft, so that the elevator may be operated either from within or from without. Precautions and advantages of this kind insure added safety and convenience in the use of an elevator in such a building. Mechanical ventilation is furnished to the lecture room by a motor-driven fan blower on the first floor. Ventilators in the other rooms maintain adequate ventilation by natural means.

The floor of the main laboratory room is arranged with conduit trenches up and down and across the room, terminating at the main switchboard. Channels for clamping the machines to the floor are also inlaid in the concrete at frequent intervals. The plug boards, an item in which there is a great diversity of practice, are made up of pressed asbestos board with home-made receptacles or jacks consisting of two flat semi-flexible plates sprung so as to grip the end of the plug. The plugs are



Fourth Floor Plan.

made from brass tubing pressed flat with tapered edge and fiber sleeve. This plug board, although very simple in construction, forms an admirable means for making quick changes in the distribution test circuits.

The storage battery is located in a special room on the mezzanine landing between the second and third floors. This room is provided with special drainage facilities and adjoins the wire tower, thus making the battery available for use on all the floors. In the ceiling of the lecture room, over the lecture table, and in various other rooms, threaded iron spools are laid in the concrete. Into these spools, eye bolts may be inserted as a means for support for apparatus. Ceiling boxes in the different rooms make it possible to extend the wiring later as may be necessary. A gallery walk-way extends the full length of the main laboratory room on the south side, affording a convenient point from which to view the laboratory and also furnishing ready access to the various rooms and galleries adjacent. A telephone system connects the various offices and laboratory rooms of the electrical engineering laboratory with each other and with the main offices in the Mason Laboratory of Mechanical Engineering across the street and those in Winchester Hall to the rear.

The new laboratory, although having been in use since the beginning of the college year, was formally opened on Thursday, November 6, 1913. Dr. Dunham, through whose generosity the building was made possible, addressed the student body and referred in a delightful way to personal reminiscences in the electrical field during the past fifty years.

The apparatus thus far installed is insufficient even for present needs, but the third step in the formation of this new department will undoubtedly be to secure adequate equipment, a need always felt when larger facilities and more floor space are acquired. The advantages of the new laboratory are evident even after a few months' work under the new conditions, both in improved work and in the many advantages afforded. With additional equipment, the usefulness of the building will be further increased.

TEACHING ENGINEERS HOW TO STUDY.

BY GEO. L. SULLIVAN,

Professor of Mechanical Engineering, University of Santa Clara.

We expect engineering students to study, in fact we require them, under penalty of failure, to study a great deal. We seem to take it for granted that students have some instinct which directs them in their study and that they know intuitively how to study properly. While this is the main requirement of students we give it the least attention. If we tell a student to determine the ultimate strength of a specimen of steel we give him detailed directions how he shall go about it and we check his method very closely but we tell him to study the laws of equilibrium and then pay not the slightest attention to the manner of his studying. He may learn to repeat the laws parrot like, although we usually do not even tell him the best way to do that. He may learn the laws and connect them only with the examples given, as is illustrated by the fact that most students think of acceleration as a phenomenon connected with falling bodies only. Or he may secure a definite view of the object of the whole subject, may get its different aspects organized in his mind and may check, connect and associate the laws with as many familiar examples as possible.

Believing that there was a real need for instruction in "How to Study" the writer advised the addition of such a course to the freshman schedule and took charge of the class. In outlining the course the following effects were decided on as the results which was hoped to be accomplished by the course.

I. Teach the students how to study properly.

II. Cause them to form the habit of reading technical magazines and books.

III. Give them a general knowledge of the fields covered by different branches of engineering.

In order to accomplish these results the following outline was developed:

First. Ask the students to outline their methods of studying.

Second. Assign some question, which the students are more or less familiar with and interested in, to be studied without any suggestions of the method to be followed.

Third. Read the studies that have been made by the students to the class and ask for criticism. If the subject has been well chosen and the criticism wisely directed, the fact will be brought out that the question was really not studied at all in some cases and very poorly in most cases. This should bring home to the student the fact that he does not know how to study properly.

Fourth. Point out the main error in each paper. Some will not have recognized the question at all, most will start with some conclusion and simply defend that conclusion, many will fail to use much of the available data, etc.

Fifth. Develop a logical method of study and have the students apply this method to as many questions as possible. Show how it can be applied and have them apply it to their other lessons, to simple problems in engineering and to every-day problems of life.

Sixth. By assigning proper questions and giving references to technical magazines and books cause the students to become familiar with the technical journals and the card catalogue of the library. Choose questions in the study of which the students will get a glimpse of the big questions and the broad divisions of engineering and in the discussions bring out the things that make engineering worth while and that furnish inspiration to the students.

In the writer's class most of the students answered the question "How do you study?" by saying that they memorized the formulas and worked the asigned problems or simply

that they read the lesson over carefully and tried to understand it. Usually there was no idea of studying with the idea of learning the relation of the parts studied to the whole subject or getting a broad understanding of the subject or of checking the author's statements or of applying the rules or formulas to any but the applications given in the text.

The first subject assigned was "Would it be practical to depend on electricity for heating and cooking if you were building a new house here in Santa Clara?" References were given to a number of articles in the technical press. Practically all of the students declared that it would be practical to so use electricity and then gave one or two of the arguments from the magazine. Some launched into a criticism of the public service corporations and only one man in the class compared the cost of wood and gas in his own home with the reported cost of electricity and even he did not take into account the difference in rates. After discussing the papers the class agreed that they had not studied the question.

After the students realized that they did not know how to study properly we developed a method of study and applied it. The first step in this development was to determine what study is and the object of studying. The fact was brought out that there are two kinds of study, pure memory work, which is not study in its broad sense, and mental work which involves the selection of material and the drawing of conclusions. Things which are constantly used should be memorized to save time and the best way to memorize a thing is to associate it with as many things as possible in as many ways as possible. Write it down and speak it aloud so as to receive sensations from it through the hand, eye, mouth and ear.

Study in the broader sense, which includes memory work, is applied by everyone to the problems of life and is the kind of study that is most valuable to a student. The first step in this kind of studying is to determine the object of the study. We took up several textbooks and analyzed several chapters in each to determine if possible just why the author

treated the subject as he did. For instance, we noted that Smith, in his "Descriptive Geometry," first treated the representation of points, then of lines, then of planes, etc., and the reasons for this development were brought out. The students were thus led to a realization of the problem confronting an author in conveying his ideas to their minds and they saw more clearly what he was trying to do and were enabled to coöperate with him to better advantage. In the same way other elements of proper study such as an open attitude of mind, schedule of study time, absence of distractions, collecting data, arranging data, checking data, drawing conclusions, memorizing and application were taken up and applied.

Familiarity with the technical press was given by assigning such problems as "What are the opportunities for the technically trained man in the automobile industry." The first step in this study was a determination of the object of the study and obviously the object of this study was to enable each man to answer the question "Shall I enter the automobile industry?" Such questions as this enabled us to accomplish the three primary results noted above.

Some students are glad to know there is a proper method of studying and conscientiously try to follow it with good results; others, knowing the better way, make no effort to follow it but are content to follow the slipshod methods they are in the habit of using. In general, students will learn whatever is required of them and if the instructor lays stress on memorizing rules and formulas instead of on understanding the subject, that is what the student will do. On the other hand, if the instructor will explain the object of the next lesson and what the author is trying to accomplish in it, the students will be able to apply the elements of proper study to much better advantage.

SOCIALIZING OUR ENGINEERING EDUCATION.

BY W. H. RAYNER,

Instructor in Civil Engineering, University of Illinois.

It is a common thing in these days to inquire rather closely what the purpose of a college training is and how nearly the average college attains this purpose. The question is well put by Mr. Edward Bok, "Is the college making good?" Nearly everyone is ready to give a statement of the aims of true education and it is natural that there should be a wide range of opinion on so fundamental a question, depending on the point of view. The employer, the editor, the college professor will surely judge the efficiency and adequacy of the work of our colleges by different standards. Three examples will suffice as illustrations.

Mr. Ivy L. Lee, executive assistant, the Pennsylvania Railroad, has stated (October BULLETIN, p. 57) the experiences of a number of the officers of that railroad. He says that the graduates of the technical schools are deficient in three general particulars:

"(1) Lack of practical experience and judgment. (2) An idea that they are far superior to the rest of mankind. (3) A certain narrowness of mind, inculcated through a too exclusive attention in college to mathematics and theoretical science, and too great neglect of those broader subjects, such as political economy, history and general literature." He then proceeds to show how these deficiencies may be met and so fulfill the railroad man's ideal of the purpose of collegiate training.

For efficiency in his work, the editor depends on effective written discourse and so it follows that Mr. Bok bases his judgment as to whether the college is making good or not on the written replies of a number of students to a questionnaire. He concludes that "the wind seems to be blowing a little bit 'sou' sou'west' in the direction of a negative answer to the question."

The opinions of many college teachers have been rather completely summed up by saying that the purpose of a college education is to train students "to think." This may be explained, perhaps, by the woeful deficiencies in ability in this line which the teacher constantly encounters.

The Socialized Conscience.

But whatever else may be deemed essential in the endowment of a graduate by his *alma mater,* one thing is needful. Unless he emerges at the end of four years with some faint glimmering of the social responsibilities that rest upon him, a willingness to enter sympathetically into the solution of our present-day social problems, and a slight sense of the debt he owes to society which has made possible his education, who will dare to justify the efforts and expense his education has entailed? Indeed may there not be at present much justification in the view of the extremists who see in our higher education only the development in the individual of a greater ability to exploit his less favored neighbors?

We have been hearing recently on all sides the opinion that the college graduate should have, along with a thorough technical training, just these altruistic motives, or what has been termed a "socialized conscience." But where and how is he to get it? I notice in an editorial of the Bulletin for October this statement with regard to this question: "Just here is where the college comes in as a specialist. . . ." If the college is a specialist in this matter it seems to me to be making slight use of its capabilities. Can we say that our technical schools exert much conscious effort to supply that which many take for granted to be the purpose and chief qualification of the college to give? Certainly not very much, unless we rely upon the cultural effects of the "radius of gyration" or the "shear diagram" to produce the desired results.

Does Responsibility Exist?

It can easily be shown that intellectual training is not necessarily moral or ethical training. While it is easy to draw

analogies and conclusions from the facts of science and mechanics which should aid in moral and ethical culture it does not follow that this will always be done, and when we come to realize that conscious effort on the part of our institutions to inculcate correct motives of conduct is necessary, I have no doubt that many persons will immediately say that the university has no responsibility in this line. This is the question I wish primarily to raise, "Is the university under any responsibility to create, to a small extent at least, a socialized conscience in its students?"

In answering my own question, I think it will be admitted that a responsibility may be said to exist where there is an urgent need which can be met by no other agency with equal efficiency. We all admit the existence of this need in the general field but a little emphasis on the special needs of this element in engineering education may not be amiss.

Our Problems are Modern Ones.

Mr. George S. Morrison, a past president of the American Society of Civil Engineers, took occasion in his later years to call our attention to the "New Epoch" in which we are now living, and in a small book under this title he speaks in no uncertain words of the needs and responsibilities arising from our present day industrialism. Regarding the need of a socialized conscience in our graduates, he says: "When ability to rule meant ability to defend against invasion, to maintain war against foreign enemies, government was in the hands of soldiers. As society became more complicated and a permanent administration of civil matters more necessary, domestic affairs being more important than foreign, the administration passed largely into the hands of lawyers. The legal profession was long the only educated profession whose members were available for public work. The functions of government are changing. The demands of the new epoch are not like those of the past. Safety from foreign invasion is needed less than safety from dangers which lurk within, from bad air, bad water and bad construction, from corrupt administration

and from bacteria. The rulers and governors who at first were soldiers, who subsequently were selected from men trained as lawyers, must in the future, at least in part, come from those who are educated in the utilization of the powers in nature, from civil engineers and the men who are equipped with the new education for the benefit of their country. . . . But if this profession is to do the good of which it is capable, the true spirit of individual immolation which has characterized the devoted priest of all ages must be found among its members."

Examples of Lack of the Social Conscience.

Probably one of the best examples of the need of sympathy on the part of the engineering profession with the wider community interests is shown in the horrible examples of housing and city planning which we have in most of our American cities. In how many of our cities, in which so great a proportion of our people live, can we point to any sort of an adequate plan which will ensure to the community the greatest amount possible of beauty, efficiency, health and comfort in its civic life?

Speaking in regard to this subject Mr. E. C. Jensen, chairman of the City Club (Chicago) committee on housing conditions, said: "It would seem that to be dealt with intelligently, the housing and town planning problem should be dealt with jointly by the architect, the landscape architect, the sociologist and the engineer."

Another example of the importance of this matter is the fact that last year the Conservative party in England gave the question of housing and town planning first place in its platform, even above the tariff.

And certainly we do not need to look far to see what results we may expect when our civic improvements are left to the predatory real estate and severely commercial interests. The battle going on at the present time in Chicago between the health department and the owners of the nickel theaters is a

case in point. And if we require further examples to illustrate the need of altruistic service and probity of conduct in our technical graduates, let us listen to Mr. Raymond B. Fosdick, former Commissioner of Accounts of the City of New York, in an article in the *Outlook* of January 18, 1913, p. 132. The entire article is worthy of quotation, but a few paragraphs must suffice.

"In 1911, shortly after the Asch fire on Washington Place, New York, the office with which the writer was connected made an investigation of certain rumors afloat in regard to the corruptness of inspectors in the Building Department. In the course of this investigation we subpœnaed as witnesses many of the prominent builders and contractors of the city. The testimony which some of these estimable gentlemen reluctantly gave under cross-examination was astonishing. . . . Said the president of a large construction company: 'I give them (the inspectors) an odd five dollars just the same as a tip to a bank clerk, or anybody else. It is simply an ordinary thing to give a fellow five dollars or something like that. It is a common thing, anyway.' The president of another concern testified that in erecting a building on West Thirty-sixth Street he paid an inspector thirty-five dollars. 'Why did you pay him that sum?' he was asked. 'To instruct me how to get a violation removed,' he answered frankly."

The Individualistic Point of View.

But even though they grant the need, many exceedingly able and sympathetic men deny the propriety and point out the futility and harm of the state seeking by any positive means to improve the conditions of its citizens. They believe that the function of government is "negatively regulative" rather than "positively regulative." They see that that man succeeds best who discerns most keenly the needs of his fellow men and supplies that demand. And on this principle society gets its needs and comforts supplied most effectively by depending on that element in human activity which requires the

least stimulation, namely, individual gain. Accordingly the philosophy is not bad which is expressed in the familiar phrase, "Every man for himself and the devil take the one behind." And therefore let not the university waste any time or effort in an endeavor to change the motive, which, as a senior, I heard expressed frankly by a classmate, "When I get out I shall be out for the dollar."

Contending for the same principle, Herbert Spencer brings the following contrast between state and individual action to support his argument.

"Let us contrast London and Berlin in respect of an all-essential appliance for the comfort and health of citizens. When, at the beginning of the seventeenth century, the springs and local conduits, supplemented by water carriers, failed to supply the Londoners; and when the water famine for a long time borne, had failed to make the Corporation do more than propose schemes, and had not spurred the central government to do anything; Hugh Middleton a merchant citizen, took in hand himself the work of bringing the New River to Islington. When he had half completed the work, the king came to his help, not, indeed, in his capacity as ruler, but in the capacity of speculator, investing his money with a view to profit. . . . Subsequently the formation of other water companies, utilizing other sources, has given London a water supply that has grown with its growth. What meanwhile happened at Berlin? Did there in 1613, when Hugh Middleton completed his work, grow up there a like efficient system? Not at all. The seventeenth century passed, the eighteenth century passed and the middle of the nineteenth century was reached, and still Berlin had no water supply like that of London. What happened then? Did the paternal government at length do what had been so long left undone? No. Did the citizens at length unite to secure the desideratum? No. It was finally achieved by the citizens of another nation, more accustomed to coöperate in securing their own profits by ministering to public needs. In 1845 an English company was

formed for giving Berlin an adequate water supply; and the work was executed by English contractors, Messrs. Fox and Crampton."

Men of this belief then would leave all positive efforts to be performed by individual action or by smaller groups of individuals, which in the case under discussion would mean that for altruism in our technical graduates we should depend on the native qualities of human nature, or the efforts of the church, the Y. M. C. A., etc.

The Other Side.

Opposed to this "negatively regulative" view of the function of the state stand an equal number of equally able and sympathetic men. These men see in this view the rejection on principle of all attempts on the part of the state to ameliorate or interfere with the conditions and activities of its citizens, except to maintain order and enforce contracts. They reject any effort on the part of the government to regulate commerce, to provide parks and playgrounds, or to promote the health of the community in any way, to protect our women and children from inhuman labor conditions or to insist that employers shall assume any responsibility for the life and limb of their employees.

It is not surprising, then, that many men hold a different view, men who believe that the state in its coöperative capacity should be "positively regulative" as well as "negatively regulative"; that it can, with ease and effectiveness, perform certain services better and more economically than can any individual or group of selfish individuals. Mr. Huxley, in supporting this view, says (*Fortnightly Review*, Vol. 16, p. 529): "Suppose, however for the sake of argument, that we accept the proposition that the functions of the state may be summed up in the one great commandment—'Thou shalt not allow any man to interfere with the liberty of any other man.' I am not able to see that the logical consequence is any such restriction of the power of government as its supporters imply.

If my next-door neighbor chooses to have his drains in such a state as to create a poisonous atmosphere which I breathe at the risk of typhus and diphtheria, he restricts my freedom to live just as much as though he went about with a pistol, threatening my life; if he is to be allowed to let his children go unvaccinated, he might as well be allowed to leave strychnine lozenges about in the way of mine; and if he brings them up untaught and untrained to earn their living, he is doing his best to restrict my freedom, by increasing the burden of taxation for the support of gaols and workhouses which I have to pay."

And in our own time he might have added, if the state educates architects and engineers who subsequently, for individual gain, evade the building laws, it is restricting the right of its citizens to protection of life as much as though it withdrew its policemen from the streets.

What Should be Done about It?

If these arguements are held to be good and accordingly we grant that the state may use positively regulative measures to the benefit of all its citizens; if it seems proper to educate our youth in the technical professions in order further to develop the industrial activities of our civilization, does it not seem proper and even imperative that these educational institutions should take some care and use some effort to the end that this training should not be used by individuals who have no regard for any interests but their own?

Now if the state institutions of technical education are under any obligation to supply what many think is indispensible in a complete education, what are some of the ways and means which may be employed to attain this end? If a few practical suggestions are offered, they are presented more in the hope that they will call out better ones than that they shall be considered "pet theories" or even workable propositions. It is more the concern of the author of this article to call attention to whatever responsibilities exist in the matter, be-

lieving that if this can be done, far wiser and better plans will be discovered to accomplish the desired results.

First, with regard to curriculum changes; if a composite conclusion might be drawn from the discussions at the recent meeting in Minneapolis, it might be stated as follows: Our present courses of study lack *thoroughness* in establishing a sure foundation in the principles of mathematics, physics and mechanics; and tend toward too great an elaboration of details in special subjects, to the exclusion of the broader subjects which bear directly on our social and political life. Is it not time to make some bold changes here? Much of the time spent in detailed design in our junior and senior years, I believe, could be spent to far greater advantage in other pursuits. If the fundamental principles of mathematics, physics and mechanics are thoroughly ingrained, then in whatever vocation the student may enter he may be expected to acquire the detailed knowledge of his vocation, rapidly enough in actual practice.

More Social Science in the Curriculum.

I believe that it is more important for a senior to gain a good comprehension of present-day labor problems than to spend six or eight hours per week in detailing a plate-girder bridge; and, as an academic means to equip an engineering graduate for intelligent citizenship, it would be more profitable for him to consider the fact that between 10,000,000 and 20,000,000 people in our prosperous America are near the poverty line, and design measures of relief for them than to design a gas engine. It is in this connection that we should hear the words of Jane Addams, "It will certainly be embarrassing to have our age written down triumphant in the matter of inventions, in that our factories were filled with intricate machines, the result of advancing mathematical and mechanical knowledge in relation to manufacturing processes, but defeated in that it lost its head over the achievement and forgot the men."

My contention, then, is that there should be more room in our curricula for such subjects as logic, economics, and political science—especially city government, civic design and sociology. Enough of the latter at least to open the eyes of our students to the trend of things in our social life. These subjects would probably better be elective, for who does not know the attitude with which most of our engineering students enter the required courses in English or economics outside the engineering college?

Such a change in our curricula ought to equip our graduates with a wider vision, a more sympathetic spirit, and a realization that each member of our society cannot by any possible means escape the responsibility for the conditions which affect the other members; that each of us is a part, a cell of the body politic and the common lot of all is helped or hindered by the attitude of each.

The elementary schools seemingly accept their responsibility and are responding slowly in the matter of curriculum changes. For instance, in the public schools of Chicago, since 1909 there has been substituted an adapted study of Chicago for eighth-grade algebra, "to make good citizens alive to the needs of their communities." And a particularly convincing plea for similar changes in our high school studies is made by Mr. William Hughes Mearns, of the Philadelphia School of Pedagogy, in the *Outlook* of July 13, 1912.

A Right Attitude on the Part of Instructors.

Next in importance as a factor in socializing our engineering education, I should put the attitude of the instructors and professors. Not only those teaching the so-called humanitarian subjects, but every instructor who is resourceful and right-minded, will find opportunities to inculcate correct social principles in the students and in so far equip them with those qualities of citizenship which our democracy demands. Now it must not be supposed that this implies that the instructor must assume the rôle of a preacher and appear before

his students in Prince Albert coat and black tie, nor will it be necessary for him (as Hugh Black has put it) "to slop over ethically." It is a matter which admits of no definite suggestions, perhaps, but what this influence may mean is well shown in the following words in which senator Robert M. LaFollette refers to Mr. John Bascom who was president of the University of Wisconsin when the former was a student there. Mr. LaFollette says: "He was the embodiment of moral force and moral enthusiasm; and he was in advance of his time in feeling the new social forces and in emphasizing the new social responsibilities. His addresses to the students on Sunday afternoons together with his work in the classroom were among the most important influences of my early life. It was his teaching, iterated and reiterated, of the obligation of both the university and the students to the mother state that may be said to have originated the Wisconsin idea in education. He was forever telling us what the state was doing for us and urging our return obligation not to use our education for our own selfish benefit, but to return some service to the state."

Directing the Students' Outside Reading.

A great deal can be accomplished by the wise direction and encouragement of the students' outside reading. Often it requires no more than a glimpse of the scope and policy of some organization, book or periodical to enlist the interest of a student in something worth while. How many seniors in our courses in engineering can state with any definiteness the editorial policy of more than one of our national magazines or great daily newspapers? In my own limited experience, I have known one junior in a large university who never had been inside the general library! Such a student is going through the university like a horse with blinds. And I am not inclined to blame the student so much as I do the instructors who find the text-books so all inclusive of the matters of

education, as not to require even a hint of some of the 250,000 volumes in the library.

Engineering biography or "hero worship" may be enlisted to good advantage in seeking the desired ends. We sometimes hear of the "contagion of character," and if we should expose our students to contagion from the characters of our greatest engineers they would surely catch some of the altruistic spirit and unselfish enthusiasm which characterized their work.

Conclusions.

This is only a small beginning toward a list of possible means of socializing our engineering education. Other and more excellent methods will be devised when we seriously recognize the responsibility and when we consciously endeavor to equip our graduates with the kind of education which Huxley defined as follows: "Education is the instruction of the intellect in the laws of nature, under which name I include not merely things and their forces, but men and their ways; and the fashioning of the affections and the will into an earnest and loving desire to live in harmony with those laws."

PHYSICS FOR ENGINEERING STUDENTS.

BY PAUL CLOKE,

Assistant Professor of Physics and Electrical Engineering, Rhode Island State College.

As sort of an aftermath of articles that have appeared and to give some of my own views on the subject, I would like to call attention to the following. I find the greatest difficulty of all to be to get students to read the subject matter "with understanding," to visualize, to "picture to themselves," to realize that the matter they are studying in the text-books concerns phenomena that are taking place in the world about them, perhaps in the very floor beams under their feet. They

fail to realize that a mathematical equation in physics is nothing but a formulation of a law or a short-hand way of expressing a natural phenomenon. For instance, I have noticed quite a discussion as to the best way of defining the unit of force. I find no great difficulty in developing the idea of an absolute unit of force, the dyne, when I present a mental picture of what is happening to a mass of a gram under the necessary conditions. Then again the use of high-sounding names is confusing and often meaningless to students. I have met with better success by calling things by descriptive names, for example, the law of fluid pressures on submerged and floating bodies, with an after remark—"discovered by Archimedes and sometimes named his law." I place the emphasis on the law itself and do not allow the student to get into a habit of "memorizing." In fact to label every natural phenomenon as somebody's law, Boyle's Law, Gay-Lussac's Law, etc., etc., is to encourage the student to become an expert in memory tests. It does not train him in originality and independent thought, and it leads him away from the essence of the matter. He comes to feel that a mathematical equation in physics is nothing but an added burden, the object of which seems to be mental gymnastics. I recently heard the head of the mathematics department in one of our American colleges declare that it is a waste of time for a student to interpret a mathematical equation in physics as being the formulation of a law. "Work out the result," said he, "that is what we want." I think this is to be regarded as a most unfortunate view of the matter, but I gather from my reading of the BULLETIN that some do hold this view. I feel very strongly now that my failure to look at my mathematics properly, as a student, prevented me from gaining a full and complete understanding of my physics courses, although I had as a teacher one of the most ardent admirers and disciples of Maxwell.

In my laboratory work this year I am following an entirely new plan. Students are assigned "investigations." With this they go into the laboratory and, having a complete reference library at hand, they look up all they can find and go ahead

independently to obtain their results and draw their conclusions. Upon reporting to me they are asked to furnish as much proof and corroboration of their results as possible and if the results of the investigation are lacking or incomplete they are told so, and are requested to "go at it again." They are thus thrown on their own responsibility and develop initiative and originality to a very large degree. A very close relation is established between principles and theory, and experimental verification furnishes drill in carrying on independent and original investigation in a large number of lines. The results surely vidicate the method and the method has the effect of arousing interest and producing real enjoyment of the work. The old plan of receiving written instructions, "taking data" and writing up reports according to certain "rules," deadened interest and made the students "automatic grinders."

STUDENT BRANCHES OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

BY D. D. EWING,
Assistant Professor of Electrical Engineering, Purdue University.

In response to a suggestion contained in the report of the Committee on Improvement in Electrical Engineering Laboratory Instruction, printed in a recent issue of the BULLETIN, I have prepared the following suggestions regarding an important phase of instruction in electrical engineering. The same principles apply also in other engineering branches. I regard student technical society work as an almost essential element in technical instruction.

The object of this paper is to set forth briefly the principal functions of the American Institute of Electrical Engineers student branch and to outline the methods which the writer, while connected with one of the smaller technical schools of the country, used with some success in conducting one.

The three parties concerned in the activities of a branch are: (1) the student, (2) the university, and (3) the Institute. If

the branch is properly conducted, the interest of all the parties concerned will be carefully considered.

To the student, the branch should be of value for the following reasons:

(*a*) It gives him an opportunity for practice in presenting and discussing papers before an assembly.

(*b*) It puts him in touch with the engineering problems of the day.

(*c*) It gives him occasional opportunities to see and hear well-known engineers, and, through the publications of the Institute, puts him in touch with what other leading engineers are thinking about and doing.

(*d*) It interests him in the Institute and makes it more probable that he will keep up his connection with it after he has left school, and that he will take active part in such section meetings and conventions as he may attend.

(*e*) It gives him training in organization and management.

(*f*) It enables him to gain information on some subjects which usually can not be included in the regular curriculum.

To the university the branch is of value because

(*a*) It is an aid in finishing the product of the university, viz., the student.

(*b*) A vigorous, well-conducted branch enhances the good name of the university and increases its standing with other universities and with the engineering fraternity at large.

(*c*) It affords an opportunity for giving instruction in certain subjects which, although important and of interest to the student, may not fit in well with the regular curriculum.

To the Institute the branch is of value because

(*a*) It gets the future electrical engineers of the country interested in the society and its purposes.

(*b*) As a means for "the advancement of the theory and practice of electrical engineering and of the allied arts and sciences," the branch helps the Institute to accomplish some of its primary objects.*

In order to attain the above mentioned ends, the following

* Quotation is from the A. I. E. E. constitution.

are some of the conditions which should be met in conducting the work of branch:

(*a*) Meetings should be held at as nearly regular intervals as is possible.

(*b*) In general the programs should be given by the students themselves, although occasional addresses by well-known engineers, on subjects of general interest, may be given.

(*c*) The membership should be as large as possible.

(*d*) Members of the branch should be enrolled students of the Institute.

(*e*) All members should be present at every meeting.

(*f*) Papers and addresses should be on subjects which the students can understand and in which they will be interested.

(*g*) A large number of students should take active part in the programs and in the discussions.

The plan followed by the writer is as follows:

(*a*) Meetings were held monthly.

(*b*) Members of the branch consisted of enrolled students of the Institute, local members of the branch, and local members of the Institute.

(*c*) Local members of the branch only were charged membership fees. The payment of the required Institute fees admitted all others to branch membership.

(*d*) The programs were usually given by the students although occasionally an outside speaker was secured.

(*e*) The papers presented at the meetings were either abstracts of papers read before the Institute or original papers.

(*f*) In addition to the men who presented the papers the program committee appointed at least two to prepare some discussion on each paper to be presented.

(*g*) A card announcing the date of the meeting and the program, was mailed to each member a couple of days before the meeting.

(*h*) Wherever feasible in the regular work of the university, students were assigned to abstract some paper published in the *Proceedings* of the Institute which had a bearing upon the subject being studied in class at that time.

(*i*) The student secretary was required to write up all news notes for publication in the *Proceedings,* and in the local student publications.

(*j*) The executive committee, consisting of the head of the electrical department, the president and the secretary of the branch and two others elected from the student membership, also constituted the program committee.

(*k*) The members of the branch, except under special conditions, appeared on the program in alphabetical order.

(*l*) Once a year a short inspection trip was taken by the branch to some nearby place of engineering interest.

It may seem that the meetings should be held oftener than once each month. However, the demand on the average student's time is rather heavy in the modern university and his regular work, if well done, takes a large percentage of it. Athletics and other student activities absorb a great deal more. Proper preparation for too-frequent meetings becomes burdensome and the meetings are liable to lose in enthusiasm. On the other hand the interest is liable to die out between meetings if the intervals are too long.

All of the upper classmen in electrical engineering should be members of the branch. The lower classmen, unless they have had considerable practical experience, will in general not have had enough preparation to enable them to become interested in the discussions.

Requiring fees of the local members only, tends to increase the number of enrolled students. Enrolled students of the Institute receive the monthly *Proceedings* and naturally will be more interested in the work of the Institute and the branch, than students who are only local members of the branch.

In general, the meetings will benefit the student in proportion to the amount of energy he puts into them. For this reason the programs should in general be given by the students and should get as many of them into action as possible. It seems preferable that several of the students should be prepared to discuss a paper which is to be presented by another student. The paper may be either an original paper or an

abstract of a paper which has been printed in the *Proceedings*. The men appointed to discuss the paper will usually act as leaders in the discussion and pave the way for a spirited general discussion in which many of the other members will take part. If courses of lectures, delivered by outside engineers, are not maintained by the university, it is well worth while for the branch to secure some outside engineer of experience and reputation to deliver an address at an occasional meeting. Such addresses are almost always of interest to the students, who like to see the " man who wrote the paper."

Mailing each member of the branch a notification of a coming meeting helps to hold up the attendance. The use of cards similar to those used by the Institute sections in announcing coming meetings is desirable. The receipt of one of these cards on which are printed the emblem of the Institute and the name of the branch tends to impress the student with the importance of the meeting. If the notice is received too long beforehand it is laid aside and the meeting time forgotten. If the time of notification is too short, previous engagements are liable to conflict, and the student does not have time enough to think over the subject to be discussed.

Requiring the student secretary to write all news notes for the *Proceedings* and local student publications is a good thing for the particular student who holds that office and helps keep up his enthusiasm for the branch. The fact that his report will be printed in the official organ of the Institute impresses him with the importance of the work, and if he is the right man for the place, his impressions will spread with beneficial results to the rest of the students. It is of course good policy to have some member of the faculty criticize the reports before they are sent to the Institute headquarters.

If all of the members are not required to take part in the programs in some definite order some of them will try to evade responsibility. Usually those who do not wish to take part in the programs are those who need the work most.

A short inspection trip made by the branch once or twice a year acts as a "get together" agent and increases the interest and loyalty of the members.

It is of course understood that the conduct of the branch should be governed by a written constitution of some sort, and the control nominally in the hands of the students. The tactful and diplomatic teacher, however, will have little difficulty in having the rules of conduct drawn in accordance with his ideas and in having the right men elected to the various offices of the branch organization. A little careful work in the office, with a few of the leaders among the students, will often be of more value in increasing the enthusiasm and attendance at branch meetings than hours of lecturing.

After all, any plan of conduct is in itself of little value. The factor that is most important of all is a live and enthusiastic faculty. If a branch is to be successful, every member of the electrical faculty from the head professor to the humblest assistant must be an enthusiastic supporter of the branch and the Institute. The students will follow in the footsteps of the faculty (in some things at least). Nothing begets enthusiasm like enthusiasm and nothing kills enthusiasm like indifference. Casual remarks; such as, "What did you think of the Institute meeting last night?," or "I do not believe that I noticed you at the Institute meeting last night," dropped by several members of the faculty to a student who has been delinquent in attendance will usually help out wonderfully in improving the attendance record of that particular student. If the faculty members are careless about their attendance at branch meetings and by their attitude indicate that they think the branch is a sort of "play affair," the students will soon think likewise.

Nothing new or original is claimed for the plan of conduct outlined above. It worked, in the particular school in question, very successfully. While the same plan might not work out as successfully elsewhere, these notes are written in the hope that they will at least arouse some discussion and possibly secure some further contributions to the BULLETIN on a subject which should be of interest both to the members of the Society for the Promotion of Engineering Education and members of other engineering organizations.

GENERAL EDUCATIONAL AND COMMERCIAL PRACTICE IN LETTERING. AN INQUIRY INTO PRESENT CONDITIONS.

BY HAROLD ORDWAY RUGG,

Instructor in General Engineering Drawing, University of Illinois.

THE PROBLEM.

A. To determine the present status of the teaching of lettering in the engineering colleges of the United States.

B. To determine the present commercial practice in lettering, as found in representative engineering companies throughout the country.

C. To devise such scales of measurement and methods of instruction as will aid in correlating the teaching of lettering with the needs of engineering practice.

This investigation and the experimental studies that are now being carried on by the writer are based upon the following premises:

1. The belief that there is a need for standards in engineering education.

2. The recognition of the necessity of dealing with simple, fundamental processes in attempting to establish such standards.

3. The agreement of practicing engineers and teachers of engineering that the ability to letter neatly and quickly such simple styles as are now used by engineers is an essential fundamental ability that should be developed in the training of engineering students.

4. The belief that practically all students of college age can develop the ability to letter neatly and quickly these simple styles.

5. The belief that our colleges are not succeeding in developing this essential fundamental ability.

6. The belief that the process of free-hand lettering as applied to simple styles is capable of analysis and standardiza-

tion and is subject to the development of standard methods of instruction.

A. The Present Status of the Teaching of Lettering in the Engineering Colleges of the United States.

Securing the Data.

In May, 1913, the writer with the collaboration of the department of general engineering drawing, University of Illinois, sent to 118 higher educational institutions now giving a four-year course in engineering, a questionnaire asking for specific data on the subject-matter and methods of their lettering instruction. These 118 institutions included practically all technical schools, private colleges and universities, state universities and land-grant colleges now giving engineering instruction, none of the larger and more important ones being omitted. From these institutions 71 replies were received, distributed over a four-fold classification adopted by the writer as follows: 8 technical schools (*e. g.,* Rensselaer Polytechnic Institute; Massachusetts Institute of Technology; Worcester Polytechnic Institute; Stevens Institute, etc.); 23 private colleges and universities (*e. g.,* Pennsylvania, Cincinnati, Colorado, Stanford, Princeton, etc.); 14 state universities (*e. g.,* Universities of Iowa, Montana, Virginia), and 26 land-grant institutions (*e. g.,* Illinois, Purdue, Cornell, Kansas Agricultural College, Nebraska). It seems quite evident that we have here data from a sufficiently wide field to give the information desired.

Turning to the questionnaire reproduced herewith, the data secured included, under the head of "Theory," the specific texts in lettering and mechanical drawing, and the number of recitations and lectures held in lettering; and under the head of "Practice," the general organization of the course, the styles of letters taught, the number of exercises devoted to drawing-room and home practice and the approximate time given to each exercise.

HAROLD ORDWAY RUGG.

Questionnaire Sent to Engineering Schools.

Department of General Engineering Drawing.
University of Illinois,
Urbana, Illinois.

(Data to be used in Investigation into Teaching of Lettering.)

A. Theory.

Lettering text used .....
Mechanical Drawing text used .....
Recitations held in lettering.
Number held per week ..... Number of weeks .....
Lectures in lettering.
Number given per week ..... Number of weeks .....

B. Practice. Formal Drill in Lettering.

(Please check "x" opposite your general method.)
Lettering taught as a separate course .....
Lettering taught as part of Mechanical Drawing course .....
Lettering taught in connection with Descriptive Geometry .....
Lettering taught in connection with upper class courses .....
Please name these upper class courses .....
(Please check style or styles of lettering used, if found below.)

	1	ABCDEFGHIJKLMNO abcdefghijklmnopq Gear Blanks.
	2	ABCDEFGHIJKLMNO ABCDEFGHIJKLMNOPQ GEAR BLANKS.
	3	ABCDEFGHIJKLM abcdefghijklm Gear Blanks
	4	ABCDEFGHIJKLM ABCDEFGHIJKLMNOP GEAR BLANKS

If above samples do not contain style used please enter here a few letters (capitals and lower case) as used in your practice .....

Drawing Room Practice.

(Please give in spaces below the number of exercises in lettering per week and the approximate time spent per exercise.)
Number exercises per week .....
Approximate time spent per exercise .....

PRACTICE IN LETTERING.

Home Exercises in Lettering.

Number of exercises per week .....
Approximate time spent per exercise .....
If you know of any scientific studies of efficient methods of teaching lettering, will you please state here where the data may be found?.....
.....
.....
If you have any suggestions as to peculiarly efficient methods of teaching lettering we should appreciate an outline of such or a communication from you concerning the same .....
.....
.....
.....

TABULATION OF THE DATA.

The data from these 71 returns were next tabulated as given in Table No. 1. Reading from this table we get a broad and yet detailed view of the procedure at each engineering college. For example, at the Rensselaer Polytechnic Institute we find from our table that French and Meiklejohn's lettering text is used; that no mechanical-drawing text is used, dependence being placed on sketches; that no recitations are held in lettering; that lectures are given only incidentally in the drawing room; that lettering is taught as a separate course during the first three weeks of the semester; that it is also given in connection with mechanical drawing and descriptive geometry and incidentally with courses in bridge drawing and detailing; etc. The material included in Table I, under "Further Explanatory Notes," consists of abstracts of remarks in answer to questions on suggestions for efficient methods of instruction. It should be stated that no specific answers of value were obtained in regard to the question on *scientific studies* of efficient methods of teaching lettering. Evidently the few who submitted data misinterpreted that question for the references proved to be far from *scientific studies* and were so varied in character as not to be capable of tabulation. However, all suggestions of value have been included under the "Notes."

Frequency tables for each item under consideration were

next drawn up, showing the number of colleges adopting each individual method of procedure. For example, if one desires to know the general practice throughout the country as to styles of letters used, Table IX, a table of frequencies, drawn up from the data in Table I, shows that 21 use style No. 1; one uses No. 2; one uses No. 3; three use No. 4; etc. Summarizing, 33 use the slant style only and 4 use the vertical. If we wish to differentiate the practice of various types of institutions (technologies, private colleges, etc.), we may do so from this table. Thus we find that Tables II to XIV give the summarized data for our determination of present practice in any phase of lettering instruction found in our engineering colleges.

Discussion of Present Practice.

I. *Theory.*

Table II.

General Organization of Instruction.

	Technologies.	Private Colleges.	State Universities.	Land Grant Colleges.	Totals.
Lettering taught as:					
A separate course	3	3	2	1	9
With mechanical drawing	6	19	13	25	63
With descriptive geometry	3	9	4	9	25
With upper class courses	1	2		2	5
Incidental with upper class courses		6	4	7	17

Nine colleges out of 71 report that lettering is taught as a separate course. Reference to our data sheets shows that in the case of three of these, this separate course is merely a three-weeks course preliminary to mechanical drawing and that in only four colleges is a separate course given in lettering apart from mechanical drawing and descriptive geometry. That the present tendency in American engineering schools is to combine the teaching of lettering with mechanical drawing is

TABLE III.

LETTERING TEXTS USED.

Text.	Technologies.	Private Colleges.	State Universities.	Land Grant Colleges.	Totals.
Reinhardt	1	7	8	6	24
No text used	1	2	4	9	16
Blue prints, etc.	1	3		5	9
French (drawing)		2	3	1	6
Adams (plates)	1	1		1	3
French and Meiklejohn	1			2	3
Fellows	1		1		2
Fish		2			2
Daniels		2			2
Adams (drawing)				1	1
Amer. Mch. Handbook					
Anthony		1			1
Blessing and Darling		1			1
Cross					
Dietzgen (alphabets)				1	1
Faunce					
Fry					
Guisecke					
I. Corres. Schools				1	1
Jamison				1	1
Maham					
Marshall					
Mathewson					
Meinhardt		1			1
Parson				1	1
Phillips and Orth					
Sherman		1			1
Smith	1				1
Spooner					
Starkey	1				1
Spooner and Davies					
Titsworth				1	1
Willson, F. N.		1			1
Wilson and McMasters					
Tracy					
Graves					
Low and Bevis					
Miller, H. W.				1	1
Reid					

clearly shown by the facts of our table; 63 of the 71 use this method, 25 teach lettering in connection with descriptive geometry, 5 give separate upper-class courses in lettering and 17 emphasize it in connection with various upper-class courses in bridge design, detailing, mapping, etc. Further remarks

on this upper-class emphasis, as submitted with our questionnaires, indicate that this teaching is everywhere quite incidental and that the results obtained leave much to be desired.

TABLE IV.

MECHANICAL DRAWING TEXTS USED.

Text.	Technologies.	Private Colleges.	State Universities.	Land Grant Colleges.	Totals.
Reinhardt					
No text used	1	2	1	1	5
Blue prints, etc.	2	4		4	10
French (drawing)		6	7	9	22
Adams (plates)					
French and Meiklejohn					
Fellows	1				1
Fish					
Daniels			1		1
Adams (drawing)					
Amer. Mch. Handbook	1				1
Anthony		5	1	1	7
Blessing and Darling		1		1	2
Cross			2		2
Dietzgen (alphabets)					
Faunce		1	1		2
Fry		1			1
Guisecke				1	1
I. Corres. Schools					
Jamison				2	2
Maham		1			1
Marshall			1		1
Mathewson		1			1
Meinhardt					
Parson					
Phillips and Orth				1	1
Sherman					
Smith	1				1
Spooner			1	1	2
Starkey	1				1
Spooner and Davies	1				1
Titsworth				1	1
Willson, F. N.		1			1
Wilson and McMasters				1	1
Tracy			1	3	4
Graves		1			1
Low and Bevis		1			1
Miller, H. W.				1	1
Reid		2			2

TABLES III AND IV.—TEXTS USED IN LETTERING AND MECHANICAL DRAWING.

Examination of Table III shows that in 71 colleges, 16 use no lettering text and 9 use blue prints, loose leaflets, notes, etc., designed by their own departments. In short, over 30 per cent. use no formal text in lettering and *20 per cent. have no organized formal aids to develop a technique which is admittedly a necessary skill in the equipment of the young engineer.* Of the 16 using no texts or mechanical aids, 13 are found among the state universities. Of the remaining 46 institutions, 24 or over one half use Reinhardt's "Free-hand Lettering." The wide influence that the work of the writer of this book has had is further shown in the tables giving the styles used. As noted in detail in Table III, *the subject-matter of lettering courses in our engineering colleges has already become standardized, i. e.,* that Reinhardt's standard style has already become adopted in practically every engineering school in the country. The only other fact of interest to be gained from this table is the great diversity in texts used. As incidental to this report on lettering Table IV is given in order that some additional light may be thrown on our problem.

From the above we find that the central tendency is to hold no recitations in lettering, 67 per cent. having adopted this practice. Of the 23 institutions holding recitations, 11 meet once a week, 6 twice, 2 three times and 4 have only incidental

TABLE V.

RECITATIONS HELD IN LETTERING.

No. Held Per Week.	Technologies.	Private Colleges.	State Universities.	Land Grant Colleges.	Totals.
None per week	7	14	9	17	47
1 per week	1	3	1	6	11
2 per week		2	3	1	6
3 per week		2			2
Incidental with drawing recitation		1	1	2	4

discussions in the drawing room. To determine more accurately the extent of recitation work we need to know the number of weeks during which recitations are held.

TABLE VI.

NO. WEEKS RECITATIONS ARE HELD.

Number of Weeks.	Technologies.	Private Colleges.	State Universities.	Land Grant Colleges.	Totals.
1				1	1
2		2			2
3		3		1	4
4		1	1		2
6			1	1	2
7		1			1
8				1	1
10			2	1	3
11				1	1
13		1			1
16				1	1
20	1				1
30				1	1
36		1			1

Reading from this table we find no typical practice, the number of weeks recitations are held ranging from one in the case of one college to three in the case of four; to ten weeks in the case of three; and sixteen, twenty, thirty and thirty-six weeks in the case of one each. It seems from inspection of the data sheets that in the case of three of the last four institutions, incidental discussions of lettering in the mechanical drawing class have been listed as separate recitations in lettering. However, they are at the most extreme exceptions and can hardly affect our determination of typical practice to-day. From a general survey of Tables I and VI, it seems safe to say that the tendency in recitation work in lettering is decidedly toward concentrating the work into the first six or eight weeks of the freshman year. One half of those reporting lettering recitations give all of these within the first six weeks.

PRACTICE IN LETTERING.

TABLE VII.

NUMBER OF LECTURES PER WEEK.

	Technologies.	Private Colleges.	State Universities.	Land Grant Colleges.	Totals.
None per week	6	9	9	14	38
1 per week	1	7	1	4	13
2 per week				1	1
3 per week		1			1
4 per week		1			1
6 per week		1			1
Incidental in drawing room	1	3	4	6	14

TABLE VIII.

TOTAL NUMBER OF WEEKS LECTURES ARE GIVEN.

Number of Weeks.	Technologies.	Private Colleges.	State Universities.	Land Grant Colleges.	Totals.
1				1	1
2				1	1
3		4		1	5
4		3	1		4
6				1	1
8		2			2
11				1	1
15		1			1
16–18				1	1
20	1				1
36		1			1

From Table VII, of sixty-nine institutions reporting, thirty-eight or fifty-five per cent. give no theoretical instruction through lectures; thirteen give one per week; one gives two; one gives three; one gives four; one gives six, and fourteen report incidental lectures in the drawing room. Typical practice here is quite plainly indicated. Seventy-six per cent. of the colleges investigated do not give lectures in a separate course on lettering to students. Of those seventeen reporting separate lectures typical practice is to give them in the first three or four weeks of the course. To determine the practice of specific institutions the reader is referred to Table I.

TABLE IX.

STYLES OF LETTER USED.

Style.	Technologies.	Private Colleges.	State Universities.	Land Grant Colleges.	Totals.
1	3	7	5	6	21
2				1	1
3				1	1
4	1	1	1		3
All four	1	7	4	4	16
1 and 2	2	2	1	6	11
1 and 3	1	5	2	5	13
1 and 4		1		2	3
1, 2 and 4			1		1
1, 3 and 4			1		1
3 and 4					
Slant only	5	9	6	13	33
Vertical only	1	1		2	4

We are at last in a position to answer a question of great importance to teachers of lettering in our engineering colleges, *i. e.*, "Has the subject-matter of lettering instruction become standardized?" And the answer can be stated unequivocably, "It has." Of the 71 colleges investigated *all* used the Reinhardt or so-called *Engineering News* style of letter. The only division of opinion that now remains seems to lie between the slant and the vertical types. Summarizing the above table, IX, we note a total of 33 colleges, or practically one half, now use the slant type only as opposed to a total of four colleges teaching the vertical type only. Further, 34 or practically 50 per cent. are using combinations of both styles, one for one purpose and the other for another. It seems fair to say therefore that *the general tendency at present is clearly toward the adoption of the slant letter in our lettering instruction.* It would seem then that standardization of lettering instruction has already been much facilitated by the gradual adoption by our teachers of lettering of a uniform subject-matter.

2. Practice.

Drawing Room Practice.

Table X.

Number of Institutions Giving

1 Drill per Week During		2 Drills per Week During				3 Drills per Week During			5 to 6 Hours Drill per Week During
1 Week	16 Weeks	3 Wks.	6 Wks.	8 Wks	16 Wks.	3 Wks.	4 Wks.	6 Wks.	6–8 Wks.
1	1	2	4	1	1	2	4	3	2

Table XI.

Number of Institutions Giving Various Intervals of Time to Drawing-room Practice.

Length in minutes of specific drill periods	10′	15′	30′	60′	90′
Corresponding number of institutions	1	2	3	11	1
Length in minutes of specific drill periods	120′	150′	180′	240′	300′
Corresponding number of institutions	7	5	13	1	1

Table XII.

Number of Institutions Giving Various Amounts of Aggregate Time (Hours Per Year).

Hours	3	6	7½	8	15	16	18	20
Corresponding number of institutions.	1	2	1	2	1	1	8	2
Hours	24	26	27	30	32	36	48	72
Corresponding number of institutions.	1	1	1	1	4	6	2	1

In order to determine standard drawing-room practice we must take into consideration four elements: (1) the number of drills per week, (2) the number of weeks such drills are given, (3) the length in minutes of specific drill periods, (4) the aggregate time spent on lettering throughout the year. Through an oversight in designing the questionnaire, data concerning the number of weeks of drawing-room drill was not specifically requested. However, 21 of our correspondents gave us this information voluntarily, so that we are able to estimate practice conditions closely in spite of this oversight.

That the tendency toward concentration of lettering drill into the first few weeks of the course is very marked is shown by Table X. Table XI indicates another phase of the same

policy; *emphasis on a few long periods of drill, the typical practice period ranging from 2 hours to 3 hours!!* Of 45 colleges reporting, 27 are now using drill periods of two hours or above; 39 in all have adopted periods of greater than one hour in duration. *Only three now are committed to the short 10 or 15 minute drill carried throughout the semester.* Again, turning to the table of aggregate times (XII), we find such a great diversity in practice that the range is from three total hours per year to 72 hours. Inspection of the data from the institutions considered points to 18 to 36 total hours per year, distributed in 120- to 180-minute periods, as typical practice.

TABLE XIII.

HOME WORK. NUMBER OF HOME DRILLS PER WEEK.

No. Drills per Week.	Technologies.	Private Colleges.	State Universities.	Land Grant Colleges.	Totals.
0	8	20	12	19	59
1		1	1	5	7
2		2	1	1	4

TABLE XIV.

HOME WORK. NUMBER OF HOME DRILLS PER WEEK.

Aggregate Time in Minutes.	Technologies.	Private Colleges.	State Universities.	Land Grant Colleges.	Totals.
60′		1			1
120′					
180′				1	1
240′		1			1
360′			1		1
480′				1	1

Typical practice is quite clearly marked out as regards home work in lettering. Of 70 institutions teaching lettering to engineers, 59 require no home work, seven require a single weekly drill plate at home and four have adopted the twice a week drill. That the total amount of home work done is very inadequate and that faith in the practice of home plates is but half hearted is indicated by the small amount of aggregate time devoted to it in the few institutions using the home-plate method.

Summary of Status of Lettering in American Engineering Schools.

1. *General organization of the course.*—The present tendency is to combine the teaching of lettering with the mechanical-drawing course. Very few separate courses are given and but incidental attention is given to it in advanced or upper class courses.

2. *Recitations and lectures.*—The theoretical work of instruction in lettering is not given by recitations or lectures but is presented incidentally in the course of discussions in the mechanical-drawing-room practice. Generally this instruction is presented in the drawing room and is purely incidental to the drawing course itself. Those few colleges holding recitations or lectures practically all concentrate such theoretical work at the beginning of the course.

3. *Styles of letter used.*—Teachers of lettering in engineering schools have now universally adopted a standard style for general work, notes, signatures, titles, etc., this being the so-called "Reinhardt" as given in our accompanying form. The typical practice in the use of this style is clearly toward the adoption of the slant type.

4. *Drawing-room practice in lettering.*—Formal drill in lettering is confined to the first six or eight weeks of the course in mechanical drawing. Our technological schools have carried out the policy of concentrating practically all drill in lettering into a few lengthy periods of practice, stressing especially practice periods of 120 to 180 minutes in length. *Only three colleges have broken away from this method and are spreading practice in lettering over many short periods in spite of the psychological grounds upon which such procedure could well be based.* There is also to be noted the diversity in aggregate time devoted to the work, this time ranging in various cases from 6 to 72 total hours per year. The central tendency is however to be noted between 18 and 36 hours.

5. *Home work in lettering.*—At the present time there is practically no tendency toward teaching the theory and prac-

tice of lettering to engineering students through the medium of home work.

B. Present Commercial Practice in Lettering.

To secure efficiency in the product of our engineering colleges to-day, the design of engineering courses of instruction should involve a very careful consideration of typical engineering practice. Thus the subject-matter of a sound course of lettering instruction should be worked up from the typical commercial practice found in engineering companies.

Questionnaire Sent to Engineering Companies.

Department of General Engineering Drawing.
University of Illinois,
Urbana, Illinois.

(Data to be used in Investigation into General Commercial Practice in Lettering.)

(Please check "x" opposite the style or styles used in your practice if found below.)

(Same form as in preceding questionnaire.)

If above samples do not contain style used, please enter here a few letters (capitals and lower case), of the styles most common to your practice .....
.....
.....

Do men trained in the Engineering Schools handle your style of letter efficiently? .....
.....
.....
.....

Please indicate style of letters used in your drafting rooms for various purposes listed below. Where possible refer to samples given above (*e. g.*, "General Notes," style used No. 2).

(*a*) General Notes .....
(*b*) Drawing Titles .....
(*c*) Bills of Materials .....
(*d*) Detail Signatures .....
(*e*) .....
(*f*) .....

In order to determine the styles of lettering used in present commercial practice, the questionnaire reproduced herewith was sent, in May, 1913, to 110 representative engineering companies in the United States. These companies embraced (1) bridge companies such as the American Bridge Co., the Cambria Steel Co., the Des Moines Bridge & Iron Co., the Boston Bridge Works, etc.; (2) construction companies such as the Aberthaw Construction Co., Stone & Webster, the Hennibique Construction Co.; (3) locomotive, car, machine and electric companies such as the American Locomotive Co., the Baldwin Locomotive Works, the Barney & Smith Car Co., the General Electric Company, the Electric Controller Company, Westinghouse Electric & Manufacturing Company; (4) railroads such as the Atchison, Topeka & Santa Fe, the Lake Shore & Michigan Southern, the Missouri Pacific, the New York Central Lines, the St. Louis & San Francisco, the Boston & Maine, etc. From these replies were received from 67, including representative companies in all branches of engineering work. The detailed data are shown in Table XV, and the summarized data in Tables XVI to XX given below.

Summarizing the data of the table we find that 40 companies of the 67 use slant styles only, 10 use the vertical only and 14 use combinations of both; 3 have no special style and 19 have adopted capitals for all purposes. We have here a clear indication of the hold which slant lettering has upon our engineers and draftsmen to-day, and that engineering schools, in tending toward the teaching of slant lettering, are —consciously or unconsciously—adapting the *subject-matter* of their instruction to present commercial practice.

Styles Used for Notes.—Of 56 reporting, 27, or practically one half, use style No. 1 (slant, lower case and capitals); 14 use No. 2 (slant, all capitals); 2 use No. 3 (vertical, capitals and lower case); 7 use No. 4 (vertical, all capitals), and 6 use combinations of various ones of these. Thus we find that 41 out of 56, or three fourths of the companies investigated, are using slant styles alone and only 9, or one seventh, are using

TABLE XV.

LETTERING PRACTICE IN VARIOUS ENGINEERING COMPANIES.

	Styles Used.	For Notes.	Titles.	Bills of Material.	Detail Signatures.	Other Styles, Titles and Notes.
Bridge Cos.:						
Amer. Bridge Co.	1	1	1	1	1	
Am. Steel & Wire Co.	1, 2					
Boston Bridge Works	1, 2	1	2	1	1	
Cambria Steel Co.	4	4	4	4		
Carnegie Steel Co.	2	2	2	2	2	
Chicago B. & Iron Co.	1, 2	1	2	1		
Des Moines B. & Iron Co.	1	1		1		
Lackawana Steel Co.	3	3	3	3		
Murray Iron Works	4	4	4	4	4	
Penn. Bridge Co.	1	1		1	1	
Steelon Co.	all 4	all	4	4	4	
Va. Br. & Iron Works	1	1	1	1	1	
Construction Cos.:						
Am. Engg. and Const. Co.	1					
Aberthaw Const. Co.	1	1	1	1	1	
Atlas Cement Co.	1, 4	1	4	1		
Hennebique Const. Co.	1, 3	1	3	1		
Raymond Concrete Pile	1, 2	1	2	1		
Stone & Webster	1, 2	1	2	1		
Turner Const. Co.	1	1	1	1	1	
Machinery Cos.:						
Acme Equip. & Engg. Co.	2	2	2	2	2	
Am. Hoist & Derrick	4	4	4	4	4	
Am. Locomotive Co.	4	4	4	4	4	
Babcock & Wilcox	3, 4	3,4	4	3, 4		Slant Roman.
Baldwin Locomotive Co.	1					
Barney & Smith Car Co.	2	2	2	2	2	
Bement-Niles Works.	4	4	4			
Brown Hoist. Mach'y Co.	all 4	12	1	1, 2	1, 2	
Buckeye Engg. Co.	2					
Corrugated Bar. Co.	2	2	2	2	2	
Dobbins Mfg. Co.	No particular style					
Electric Controller Co.	2	2	2	2	2	
Erie Car Works.	1					
General Electric Co.	2	2	2	2	2	
Ingersoll-Rand Co.	all 4					
J. Leffel & Co.	1, 2	2	2	2		
Lima Locomotive Works.	4	4	4	4	4	
Maine Electric Co.	1, 2	1	2	1	2	
Minn. & St. & Mach'y Co.	1, 4	1, 4	1, 4	1, 4		
Morse Twist Drill & Mch.	2	2	2	2	2	
Simonds Mfg. Co.	1	1	1	1	1	Block.
Sullivan Mch'y Co.	4	4	4	4	4	
Wellman-Seaver-Morgan.	1	1	1	1	1	
Western Electric Co.	2	2	4	2	2	
West'ghouse Elect. & Mfg.	1, 2	1	2	1		
Westinghouse Mach'y Co.	1, 2, 4	1	2, 4	2		

TABLE XV (*concluded*).

	Styles Used.	For Notes.	Titles.	Bills of Material.	Detail Signatures.	Other Styles, Titles and Notes.
Railroads:						
A. T. & Santa Fe	1	1	2	1		Roman.
Lake Shore	all 4	1	4	2		
Mo. Pacific	1, 2	1	2	2		
N. Y. C. & H. R. R.	1, 2	1	2	1	1	Block.
N. Y., N. H., & H. R. R.	1, 4	1, 4	1, 4	4	4	Block.
Railroads:						
No. Pacific	1	1	1	1	1	
Ore. Short Line	1, 3					
Wabash	all 4	2	4	1, 3		
Boston & Maine	1, 2	1	2	1	1	
St. L. & S. Francisco	No particular style.					Arch't'l.
Miscellaneous and Unnamed.						
1	1	1	1	1	1	
2	1, 3	1	1, 3	1		
3	2, 4	2	4	4		
4	No particular style.					
5	all 4	2	4	2	1	
6	1, 2	1, 2	2	1	1, 2	
7	2	2	2	2	2	
8	1	1	1	1	1	
9	3, 4	3	4	3		
10	1					
11	1, 2	1	2	1	1	
12	2	2	2	2		

TABLE XVI.

STYLES OF LETTER USED.

Style Used.	Bridge Cos.	Construction Co.	Machinery Co.	Railroads.	Miscellaneous.	Totals.
1	4	3	4	2	3	16
2	1		8		2	11
3	1					1
4	2		5			7
All four	1		2	2	1	6
1 and 2	3	2	3	3	2	13
1 and 3		1		1	1	3
1 and 4		1	1	1		3
2 and 4					1	1
3 and 4			1		1	2
1, 2 and 4			1			1
Slant only	8	5	15	5	7	40
Vertical only	3		6		1	10
Capitals only	3		13		3	19
Slant and vertical	1	2	4	4	3	14
No special style			1	1	1	3

vertical styles alone. The slight use of capitals for notes is also shown by the fact that only 15, about one fourth, have adopted this practice.

Styles Used for Titles.—Ten have adopted No. 1 (slant, l. c.); 22 use No. 2 (slant capitals); 2 use No. 3 (vertical l. c.); 16 use No. 4 (vertical capitals); 3 use combinations; 3 use a printed form, and 2 use a rubber stamp. Summarizing, out of 56 companies, 32 use slant type only as opposed to 18 using vertical only, and 38 use capitals for titles. Here again we find about the same proportionate emphasis on the use of slant types. It should be noted that capitals have been adopted by two thirds of our companies for all title work. We believe that the data as to the use of printed forms and rubber stamps are hardly a true index of the use of such in practice to-day and should not be taken as such by the reader. Much to our regret, the question was not specifically asked in the questionnaire and it is felt that the number reporting the use of such accessories would be much increased if specific data had been requested.

TABLE XVII.

BILLS OF MATERIAL.

Style Used.	Bridge.	Construction.	Machinery.	Railroads.	Miscellaneous.	Totals.
1	6	6	4	4	5	25
2	1		9	2	2	14
3	1				1	2
4	3		4	1	1	9
1 and 2			1			1
3 and 4			1			1
1 and 4			1			1
1 and 3				1		1
Typewritten			1		1	2
Handwritten						
No data	1	1	5	2	2	11
Slant only						40
Vertical only						12
Capitals only						23
Lower case only						28

In the case of Bills of Materials and Detail Signatures we note the same tendency toward the use of the slant styles, 40

TABLE XVIII.

DETAIL SIGNATURES.

Styles Used.	Bridge.	Construction.	Machinery.	Railroads.	Miscellaneous.	Totals.
1	4	2	2	3	3	14
2	1		9	1	1	12
4	2		4	1		7
1 and 2			1		1	2
Handwritten	2	1	4		1	8
Typewritten			1			1
No data	3	4	6	5	6	24
Total investigated						68
Duplicate						1
						67

out of 67 companies using slant for bills of material and for detail signatures, the proportion of slant only to vertical only being 28 to 7. Eight companies report the use of handwriting for details and one the use of the typewriter. Eleven give no data on Bills of Materials and 24 none in regard to Detail Signatures, evidently not considering it of importance from the standpoint of engineering lettering.

In answer to the request for styles used, other than those submitted in the cut, only 6 companies reported anything but the Reinhardt. Two companies submitted samples of slant block and two, samples of vertical block; one reported the use of slant Roman and one the use of vertical architectural. This meager information but reinforces our conviction as to the adoption of a single uniform style for all engineering lettering.

One more use may be made of our tabulations, namely, in answering the question, "Should students of civil and mechanical engineering be taught slant or vertical lettering?," *i. e.*, should a distinction be made between the men preparing for these branches of the profession on a basis of definite training for practical service?"

TABLE XIX.

STYLES USED BY CIVIL AND MECHANICAL ENGINEERS.

	Slant.	Vertical.	
Bridge Companies	8	3	In general, civil engineers.
Construction Cos.	5		
Railroads (M. of W.)..	5		
	18	3	
Machinery and locomotive works	15	6	In general, mechanical and electrical engineers.

In the above a rough dichotomy has been made in which companies tending to emphasize the branch of engineering generally accepted as "civil" have been separated from those known to be mechanical or electrical concerns. In the first group of "civils" we find that 18 use the slant lettering as opposed to 3 using vertical. In the second group, "mechanicals," we find that the ratio in favor of the slant is 15 to 6. *In general it seems safe to say that if one style only is to be taught to students, that slant lettering should be taught to all three divisions of the student body, civil, mechanical and electrical.*

In answer to the question, "Do men trained in engineering schools handle your style of letter efficiently?," the data are tabulated as follows:

Number answering decidedly "Yes" ..... 18.
Number answering decidedly "No"..... 17.
Number answering "Yes," after practice with us..... 12.

Such an even division of opinion seemingly leaves us in as great a quandary as ever in trying to estimate even roughly the efficiency of our present instruction in lettering. At least we may feel convinced that practically one half of the chiefs of drafting departments of American engineering companies believe that at the present time we are not training men in that fundamental ability to letter neatly and quickly. That they feel too that they, themselves, must give specific instruction in lettering to men trained in engineering schools is indicated by the fact that 8 of our correspondents sent us formal instruction sheets in lettering that are used in their offices.

C. The Correlation of the Teaching of Lettering with Present Commercial Practice.

An educational investigation of this type may properly fulfill two functions: (1) It should report in detail and in summary form the facts involved in the problem under consideration; (2) it could profitably outline various experimental methods by which progress toward the solution of the problem is being attained. It is to some experimental work on this second phase of the lettering problem that the writer wishes to bring the attention of teachers of the subject.

In the standardization of any field of educational activity a two-fold problem is always presented: (1) the design of subject-matter to be presented to the student, (2) the development of a method by which this subject-matter may be efficiently presented. In this problem of lettering, teachers of the subject may consider themselves especially fortunate that a uniform subject-matter has been agreed upon, namely, a standard style of letter to be used on all engineering drawing. That the "Reinhardt" or *Engineering News* style is now being used in both engineering education and engineering practice is conclusively shown by the tabulated results of the investigation. Thus, having already a standardized subject-matter, our real problem reduces to one of devising an efficient method by which this style of letter may be taught.

Experiments in the Teaching of Lettering at the University of Illinois.

We found in the preceding discussion of present educational practice, that the typical method used to develop technique in lettering was that of giving the student a few long periods of drill of 120 to 180 minutes each during the first four to six weeks of the course. This method in general, coupled with the use of weekly home plates during the first ten weeks, has been tried out during the past few years at the University of Illinois. Being convinced that the results secured with this method were not efficient, the writer during the past two years has

Chart Showing Improvement in Ability in Lettering.

Efficiency in Lettering–Practice Daily Letters Most Frequently Used

Material Finished Cast Steel	Section Gear Parts Keyways	Shaft Bearing	
Required Name Number View	Drill Holes Mast Studs Cover	Bronze Pipes	
Dimension All Detail Drawings	Taper Joint Lock Nuts Mixer	1234567890	

Material Finished Cast Steel	Section Gear Parts Keyways	Shaft Bearing	No. 275	First Week
Required Name Number View	Drill Holes Mast Studs Cover	Bronze Pipes	Date 2-10	
Dimension All Detail Drawings	Taper Joint Lock Nuts Mixer	1234567890	Time Lost	

Material Finished Cast Steel	Section Gear Parts Keyways	Shaft Bearing	No. 275	3rd Week
Required Name Number View	Drill Holes Mast Studs Cover	Bronze Pipes	Date 3-2	
Dimension All Detail Drawings	Taper Joint Lock Nuts Mixer	1234567890	Time 15-30	

Material Finished Cast Steel	Section Gear Parts Keyways	Shaft Bearing	No. 275	5th Week
Required Name Number View	Drill Holes Mast Studs Cover	Bronze Pipes	Date 5-1	
Dimension All Detail Drawings	Taper Joint Lock Nuts Mixer	1234567890	Time 16-00	

Material Finished Cast Steel	Section Gear Parts Keyways	Shaft Bearing	275	7th Week
Required Name Number View	Drill Holes Mast Studs Cover	Bronze Pipes	7-2	
mension All Detail Drawings	Taper Joint Lock Nuts Mixer	1234567890	8-30	

Material Finished Cast Steel	Section Gear Parts Keyways	Shaft Bearing	275	9th Week
Required Name Number View	Drill Holes Mast Studs Cover	Bronze Pipes	9-1	
Dimension All Detail Drawings	Taper Joint Lock Nuts Mixer	1234567890	9-35	

Material Finished Cast Steel	Section Gear Parts Keyways	Shaft Bearing	275	11th Week
Required Name Number View	Drill Holes Mast Studs Cover	Bronze Pipes	11-3	
Dimension All Detail Drawings	Taper Joint Lock Nuts Mixer	1234567890	9-10	

been experimenting with various methods of teaching lettering. The subjects of this experimentation show such thorough development in ability to letter neatly and quickly that a brief preliminary report will be made here of the progress already attained.

The principles upon which this experimenting has been based may be briefly summarized as follows:

1. That lettering skill is to be developed through individual instruction.

2. That the theoretic part of this instruction should be given in the first few class exercises of the drawing course, and should include the analysis and synthesis of letters and methods of making letter strokes.

3. That the drill itself should all be given in the drawing room.

4. That all practice should be given in many 10 or 15 minute drill periods, one each drafting day throughout the course.

5. That the "copy" or material for practice should be scientifically designed so as to emphasize the various letters of the alphabet in approximate proportion to their actual repetition on engineering drawings; *e. g.,* if "e" actually occurs on engineering drawings 23 times as often as "x" it should be drilled (approximately at least) 23 times as much.

6. That control of the students' rapidity should be exercised through the taking of daily time tests.

7. That faults in technique should be pointed out to each individual student and corrected by him one at a time.

8. That no slant, vertical or upper guide lines be given the student upon "copy" after the first week's practice.

9. That no grade should be put upon such practice work until a definite measuring scale for lettering is obtainable.

The putting into practice of the above principles has already resulted in a marked improvement in the lettering of all students in the writer's classes. It is not the function of this paper and space will not permit the inclusion of a detailed

description of the method through which our present practice has been developed. However, to show sample cuts of work done under this system the accompanying illustrations are submitted. In the accompanying cut are shown samples from the development of a student's ability during the first eleven weeks' practice, given for weeks 1, 3, 5, 7, 9 and 11, using the copy designed on the theory advocated in the above principles.

Believing that the student should drill most often on those letters that he is to use most often on engineering drawings, a tabulation was made of the frequency of occurrence of all the words on a large number of engineering drawings so selected as to include all types in use to-day. From this tabulation of words, the frequency of occurrence of individual letters was next noted. Words were then selected to make up the copy for the lettering form, as given in the accompanying cut, so as to very closely approximate the relative proportion of various letters in the frequency tables of letters found on the engineering drawings. That is, in the copy there will be counted e's a's, f's, etc., which will correspond very closely to the proportionate number of e's, a's and f's found on the various engineering drawings. Although this copy is not mathematically correlated to the exact proportionate use of various letters the writer feels that it does approximate this closely enough for all practical purposes.

A detailed report of the experimental work in lettering being done at the University of Illinois, will be made within the next few months. At that time a definite measuring scale for grading free-hand lettering will be submitted to teachers of lettering. This is being worked out upon a scientific basis and will be strictly adapted to class-room use, for both instructor and student. It is the hope of the writer and of the department of general engineering drawing of the University of Illinois that this investigational and experimental work in engineering education may contribute to the general advancement of the efficiency of instructional work.